FIRE CONTROL NOTES

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FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

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COVER—Typical chaparral-covered watershed, Angeles National Forest, Calif. See story on page 3.

(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)

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WHAT ARE WE GOING TO DO ABOUT THE BRUSH IN SOUTHERN CALIFORNIA?

Keith E. Klinger[1] and Carl C. Wilson[2]

The Spanish vaqueros had a name for it—"chaparro"—from which we get the name "chaparral." But more often we call it brush. Like today's firefighters, the vaqueros probably cursed the dense stand of shrubs covering the mountains of southern California. It was an obstacle to foot and horse travel. Though the Indians were using the nuts, berries, and seeds of several of the plants for food and medicine, the early settlers found the brush of little economic value. It was expensive to convert to orchards or pastures. And it burned like tinder. A few early naturalists, however, recognized the unique beauty and watershed value of this plant formation.

We will examine both the assets and liabilities of brush: its value as a vegetation type, and its hazard as a fuel and what we can do about it.

California redwoods are known throughout the world, but few people have heard of what southern Californians call their "elfin forest."[3] This forest consists of some 5 million acres of chaparral—a mixed formation of low, hard-leaved, stunted trees and shrubs. This growth is the result of short, wet, cool winters, and long, arid, hot summers. Chaparral grows slowly—shrubs 25 years old may average only 2 or 3 inches in diameter and 5 or 6 feet in height. It includes more than 150 species of woody plants. Chamise, manzanita, ceanothus, sumac, sagebrush, scrub oak, and buckthorn represent 90 percent of the growth.

In the United States, this type of forest growth occurs chiefly in southern California. Similar plant formations are found along the coast of Chile, in Europe and Asia, along the Mediterranean, in Africa near the Cape of Good Hope, and on the southern and southwestern coasts of Australia and Tasmania.

The chief economic value of chaparral is its ability to control erosion and promote rapid infiltration and thus help conserve ground water. Chaparral also provides food and cover for game animals and birds.

THREE BEST-KNOWN BRUSH SPECIES

The most abundant of the chaparral species in California is chamise (*Adenostema fasciculatum*). It grows almost everywhere throughout the range of the chaparral. Some botanists have estimated that it makes up about one-third of the cover. Chamise grows from sea level to 5,000 feet. It resprouts readily after a fire, and its longlived seeds germinate abundantly under the ashes in the mineral soil. This plant is easy to recognize because of its small, needlelike, olive-green leaves. It blooms late in the spring—after most other brush species have flowered. Then, about mid-June the mountains become white with its bloom. Later, the chamise fields turn a rusty color as the blossoms fade.

The second most common shrub is scrub oak (*Quercus dumosa*). This plant is often dwarfed in stature—sometimes not more than 5 to 6 feet tall. The crooked trunks and branches are stiff and tough, and the thickets are almost impenetrable. In good seasons some pure scrub oak stands bear a crop of acorns estimated at several tons per acre. Scrub oak can resprout from its root crown after fire. This characteristic helps make it one of the more persistent brush species. Hormone brush killers like 2, 4,-D will kill chamise, but scrub oak seems to thrive on brush-killing chemicals and is known as a "hard-to-kill" species.

A third species—California sagebrush (*Artemesia california*), a sister of the Great Basin sagebrush (*Artemesia tridentata*)—is common in many parts of the chaparral belt. Its ashy, gray-green foliage is similar to its desert relative, making it easy to distinguish from the other shrubs. It is not as aromatic as the Great Basin sagebrush, but it still has a penetratingly pungent odor when one wades through it on a hot day.

THE CHAPARRAL HAZARD

Fire behavior experts say that chaparral is the most flammable brush in the United States. Its litter and dead portions usually are easily ignited, and almost every fire is a crown fire because of the horizontal and vertical continuity of the fuel. Despite many studies of this unique fuel type, there is still much to learn. We have good evidence, though, that chaparral poses formidable problems in fire control.

For example, fuel classification and measurement procedures devised during Operation Firestop[4] showed that representative ovendry weights

[1] Chief Engineer, Los Angeles County Fire Department, Los Angeles, Calif.

[2] Assistant Director, Pacific Southwest Forest and Range Experiment Station, Forest Service, USDA, Berkeley, Calif. He is stationed at Riverside, Calif.

[3] Fultz, Francis M. The elfin forest of California. Los Angeles Times Mirror Press, 267 pp., illus. 1923.

[4] Operation Firestop was a cooperative experimental program conducted in 1954 by fire agencies and research organizations in California. The sponsors were: Los Angeles City Fire Department, Los Angeles County Fire Department, California Division of Forestry, U.S. Forest Service, and Federal and California civil defense agencies.

for typical stands were:

1. California sagebrush (mixed about 50-50 with white sage): Average height of 4 feet and about 5 tons per acre.

2. Chamise (83 percent of the stand): Average height of 4 feet and nearly 7 tons per acre.

3. Scrub oak (99 percent of the stand): Average height of 7 feet and about 21 tons per acre.

Let's examine the fuel values more closely. If we take 20 tons per acre of scrub oak at 8,500 B.t.u. per pound, we find that we have about 340 million B.t.u. per acre. Therefore, only 40 acres of dense scrub oak is required to produce the equivalent of 20 kilotons of thermal energy. That's equivalent to the energy of a bomb that could destroy a major city. Of course, this energy isn't released as rapidly as that of an atomic bomb. However, the Conejos Fire of 1950 in San Diego County burned about 63,000 acres in 63 hours. Assuming 20 tons of fuel burned per acre, that's equal to 25 bombs per hour. That's a lot of energy.

However, the ease of ignition, rate of combustion, and total thermal energy depend not only on weight but also on the arrangement, species, and, very important, on the amount of moisture in the dead and living fuels.

The moisture in light, dead brush fuels is closely related to the current humidity and temperature. However, the moisture of living chaparral in southern California usually follows a definite seasonal pattern (fig. 1). In late winter and early spring the plants put on new growth, and the moisture content of the plant increases quickly to its highest seasonal level. The new growth then matures and becomes relatively dormant during late summer and early fall. The plant's moisture content then remains near the minimum seasonal level until new growth starts again. As an extreme example, living chamise can contain 100 percent moisture in May or June —about 2,000 gallons of water per acre. But by October moisture can drop to 50 percent—1,000 gallons of water per acre. Obviously, the difference in the amount of water in the live brush can have an important influence on fire ignition and spread.

More recently, fire researchers have also learned that the highest crude fat content of chamise occurs when the moisture content of the plant is lowest. This is another reason why this fuel is so explosive during extended dry periods.

ACTION AGAINST BRUSH HAZARDS

We have a hazardous vegetative type, but what can we do about it? There are three possibilities: (1) Replace the existing hazardous fuel with "fire-resistant" plants, (2) "light burn" the chaparral regularly, or (3) do selective fuel-hazard reduction.

First, let's take a look at what have been called "fire-resistant" plants. A report of studies by the Los Angeles State and County Arboretum says:

"The term 'fire resistance' refers to the burnability of certain species in comparison to that of chamise or scrub oak, two common chaparral species. The species being compared must be grown under similar conditions. Otherwise, factors of soil moisture and climate may lead to erroneous conclusions. The studies at the Arbore-

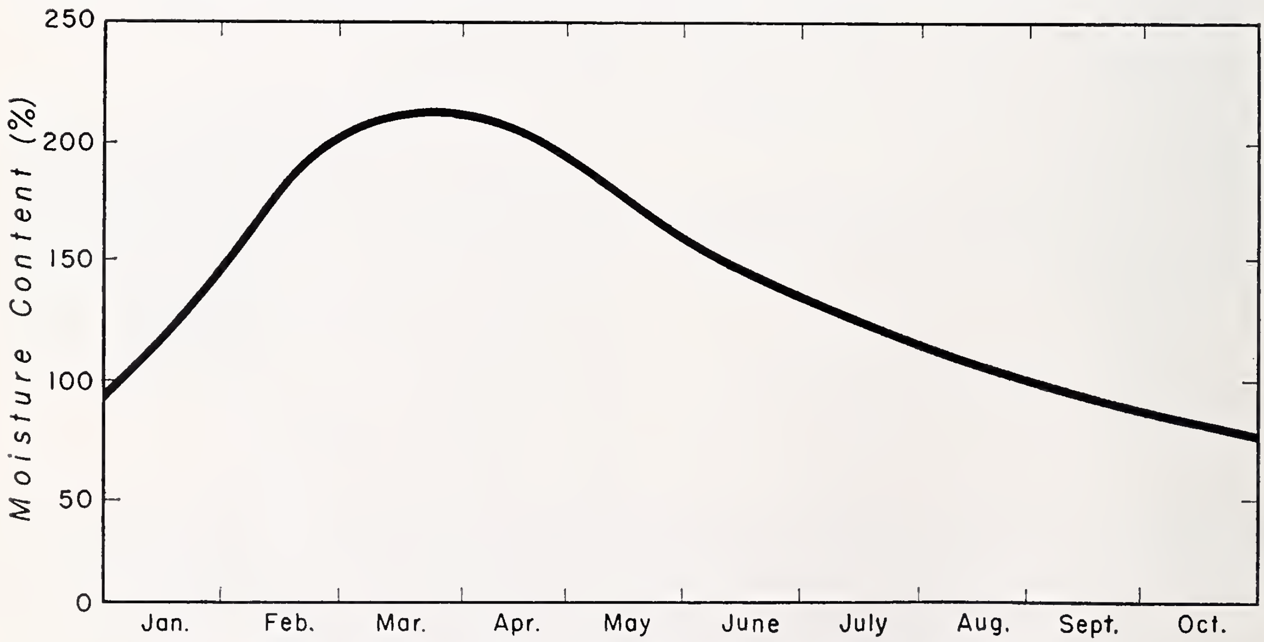

Figure 1.—Moisture content of chamise new growth, percent (typical curve).

tum have been made with this point in mind. And burning tests are made with plants grown under comparable conditions."[5]

Researchers at the Pacific Southwest Forest and Range Experiment Station are conducting limited studies on purported slow-burning plants such as cistus. But they have been unable to identify plants that they can class unequivocally as "slow burning." The Station staff is also looking for plants that are low in stature (less than 1 foot high) and fuel volume, that resist drought and damage caused by animals, and that will control soil erosion.[6] This is not a very simple order.

Our researchers have selected some shrubs to plant on fuel-breaks to test flammability. The most interesting shrubs are a low-growing saltbush (*Atriplex canescens*) and squaw carpet (*Ceanathus prostratus*). But rodents eat the saltbush, and squaw carpet doesn't seem to grow well at lower elevations. We aren't proposing, however, to stop seeking or producing "slow-burning" or "low-fuel-volume" plants. We think there are opportunities here, but we do not believe there is any present possibility that we will be able to replace all the native species with introduced species. Neither nature nor the taxpayer would permit it. In any case, it is highly unlikely that this type of plant will be the panacea for all brush problems in southern California.

What about light burning? Why don't we burn off the brush every few years so that a stockpile of hazardous fuels doesn't accumulate in our watershed?" This question has been asked by numerous laymen and scientists. Here's our partial reply.

In 1954, during Operation Firestop, we measured fuels before and after light burns on three test plots. These burns were conducted in August and September under ideal fire control conditions.[7] Relative humidities were higher than 30 percent, and winds were less than 10 m.p.h. The fires were started with drip torches, and all were set to burn with the wind. Under these easy and safe conditions, only the lightest fuel types burned completely. Burns in chamise were spotty, and scrub oak burned slowly.

The spotty chamise burns actually increased the fuel hazard by killing some plants without consuming them. Also, the heavy fuels, such as scrub oak, which can develop the most intense wildfires, would not burn under weather conditions when safe control could be assured. We think our answer today for the enthusiastic proponents of wide-scale light burning is about the same as it was in 1954: large-scale light burning in southern California straddles a fireline between twin risks:

(a) burns which increase the hazard rather than reducing it and (b) "controlled" fires which cannot be controlled.

A few successful light burning tests have been conducted in southern California during the past decade. They suggest that light burning may be useful in developing fuel-breaks or safety zones for firefighters, particularly if we modify the fuels prior to burning. But this technique has not been tested enough to warrant extensive use in southern California. More studies are needed to determine the range of weather and fuel conditions under which prescribed burning can be used safely and effectively.

Thus, the most logical of the three alternatives is fuel hazard reduction. Fuel is reduced or removed from areas where fire is most easily kindled—along roads, around residences and structures which are adjacent to or in the brushfields, and where there are vast expanses of chaparral. In the long run, we think this is the best answer.

In line with this, the California fire agencies have been conducting a cooperative research and action program called "Fuel-Break" since 1956. Its primary aim is to modify the brush fuel at strategic locations to break up the large unbroken areas of chaparral (fig. 2). On carefully selected sites, the brush is permanently changed to vegetation of light weight, low fuel volume, or low flammability, or all three. These areas, called "fuel-breaks", are at least 200 feet wide. They facilitate fire control because they can be manned soon after initial attack is started on a brush fire.

Fuel-breaks are constructed to aid in the control of fires under extreme burning conditions that ordinarily hinder control in unbroken brush fields, especially on steep terrain. But unmanned fuel-breaks are not necessarily intended to *stop* a fast-moving fire because spot fires commonly occur well beyond the head of such fires. These prepared breaks, however, can be safely manned for offensive action against headfires, and can help stop the lateral spread of the fire. Therefore, the fires can be confined earlier, and the area burned reduced.

More than 500 miles of fuel-breaks have been constructed in southern California; about 63 percent are more than 200 feet wide. Also, 5,624 acres of brush has been converted to grass for range or wildlife management. These areas, where possible, are tied into existing fuel-break systems. Much more

[5] Findings of Governor Brown's Study Committee on Conflagrations, California. 1965. (Unpublished report).

[6] Green, Lisle R. The search for a "fire resistant" plant in southern California. California Div. of Forestry Fire Contr. Exp. 10, 12 pp., illus. August 1965.

[7] Chandler, C. C. "Light burning" in Southern California fuels. U.S. Forest Serv. Calif. Forest and Range Exp. Sta. Res. Note 119, 2 pp., 1957.

Figure 2.—Grass-covered fuel-break in the North Mountain Experimental Area, east of Riverside, Calif.

needs to be done, and fortunately guidelines are now available.[8]

For the selective fuel hazard reduction program to move ahead rapidly and to be most effective, everyone must "get into the act!" Public utility agencies should study, design, and develop fuel-break systems in their high-risk areas. Planning commissions should consider the use of treated sewage effluent for the irrigation of "green belts," such as golf courses, cemeteries, and fuel-breaks around mountain communities. Public fire agencies must also remain alert to the need for protecting the lives of the millions of people who visit parks, picnic areas, and campgrounds, and who travel along highways in the brush-covered mountains. Safety zones and safe entrance and exit routes should be an integral part of their overall plans. Finally, each resident (1 of 20 Americans now live in southern California) must maintain his own property. He must assume the responsibility for

Continued on page 16

[8] Fuel-Break Executive Committee. Guidelines for fuel-breaks in southern California. Fuel-Break Rpt. No. 9, 25 pp., illus. Pacific Southwest Forest and Range Exp. Sta., Berkeley, Calif. 1963.

THE RESOURCE LOCATOR—A DISPATCHER'S AID

James W. Jay[1]

Dispatchers and fire managers must maintain a constant inventory of available firefighting resources. They must also keep an up-to-the-minute record of mobilization and dispatching actions. Usually logs, notebooks, and clipboards are used to support their memory.

Most dispatchers experience peak periods when these records and their memory are inadequate. Needed data are buried by records of subsequent action. Items are forgotten. Dispatchers are especially handicapped during shift changes—a 1- or 2-hour shift overlap is common during fire busts to permit relief dispatchers to become acquainted with the status of dispatching action.

CRITERIA FOR A SATISFACTORY SYSTEM

A system capable of overcoming these difficulties is needed. Certain basic data should be visually displayed. Storage, updating, and recall of information should be rapid and uncomplicated. The system must be quickly adaptable to various situations and levels of operation. It must be dependable and simple enough to be used with minimum instruction.

Cost is equally important. Electronic computer equipment could probably fill most requirements, but the necessary investments would severely restrict the number of units in use. This would defeat the basic aim—a simple system with widespread applications at all levels.

To be useful, the system must permit some choice of what information is displayed for quick reference, and what is stored for ready recall. The data dislayed should be limited to that which can be readily comprehended and used in making decisions. If every relevant item were shown, the mass of information would be too great to be of value.

THE RESOURCE LOCATOR

A system meeting the general requirements has been developed. While the basic concepts are not new, their application provides a simple yet effective means of maintaining a current inventory and record of the mobilization and dispatching of manpower, equipment, and supplies.

[1] Formerly Fire Control Specialist, Washington Office, Division of Fire Control (Retired).

The prototype model consisted of a set of card wall racks and blank cards. Eight racks were used; each had a capacity for twenty-five 5- by 8-inch cards. The racks were mounted in a specially constructed carrying case (fig. 1). Other sizes could readily be designed to meet specific local needs. In dispatching offices the racks could be mounted on the wall. For field use, such as in fire camps or for lookout-dispatchers, a compact model using smaller cards may be more suitable.

USE OF THE SYSTEM

Each resource item is represented by a card. The name, number, etc. of the item is written along the top edge. This is the "displayed" information when the card is in the rack. "Stored" information, including any necessary permanent data (rental rates, specifications, home base, etc.) and current dispatching information are written on the lower portion and back of the card. Color coded cards can be used for the various categories of resources. However, excessive coding may destroy simplicity.

The basic system can be easily adapted to various situations. At a dispatcher's headquarters, the card racks can be labeled "Inventory", "In-Transit", and "Assignment." When resource items are known before they are ordered or dispatched, cards would be prepared and placed in the Inventory rack as a display of available resources.

As a resource is requested or is dispatched, its card is pulled from Inventory, or a new card is made. Appropriate dispatching data (fire order number, time, destination, ETA, method of travel, etc.) would be posted on the lower portion, and the card

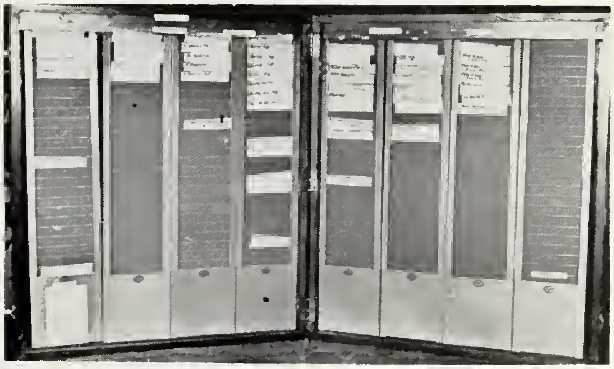

Figure 1.—These eight card racks in a carrying case can display 200 resource cards.

would be placed in the In-Transit rack. On confirmation of its arrival, the item's card is posted and placed in the Assignment section. This provides a constant display of the resources assigned individual fires, by Forests or other category.

When demobilization occurs, the process is reversed.

The same system, with only minor revisions, could be used at a fire headquarters. Racks could be labeled "Ordered," "In-Transit," and "Assignment." Here, the assignment grouping could be by Sectors, Divisions, day or night shift, etc. Thus, the top fire overhead would have a constant visual display of the current status of all resources relevant to the situation.

The flexibility of the basic system permits it to be used in many individual situations at various levels. However, if too many items are displayed, the value of quick visual reference is lost. Where many resource units are involved, it must be decided whether summaries or only segments of the mobilization should be displayed. If only summaries of the resources are displayed, the detailed data on the resources can be stored on individual cards kept in tub files for quick reference (fig. 2). For example, if it were necessary to maintain a record of a large number of crews, the display would show the total number available, in-transit, or assigned by appropriate category (fire, Forest, etc.). Detailed information on each would be recorded on cards stored in similar sections of the tub file. As the crews were shifted, the summary cards would be updated, and the individual card posted and moved to the appropriate file section.

The resource locator system was tested and used during the 1967 fire season, and personnel were generally enthusiastic. In two cases, the system was set up without card racks—once even by using shipping tags thumbtacked to cardboard cartons when cards are not available.

CONCLUSIONS

Use demonstrated that the system is an effective aid in several operations, and can significantly assist dispatchers and others in keeping control of past and current mobilization action. The basic concept of the system is simple and easily understood.

a. Prepare card identifying each resource item.

b. Post all actions pertaining to the item on the card.

c. Move the card to the appropriate display when the item moves.

By recording and displaying the data in this manner, a permanent record of action is available for quick recall. The chances for double orders, errors, and oversight are reduced, and management and decision making are improved.

ASSEMBLING THE SYSTEM

Standard 5- by 8-inch cards are used for recording the resource item information. Blank cards may be used, with all headings, etc., handwritten at the time of use, or the cards can be printed with a standard format. Gummed labels or embossed plastic tape can be used on the racks to identify resource categories.

The wall racks should provide for 1-inch exposure of the card. Suitable racks can be obtained from office suppliers. Each 25-pocket rack costs about $10.50.

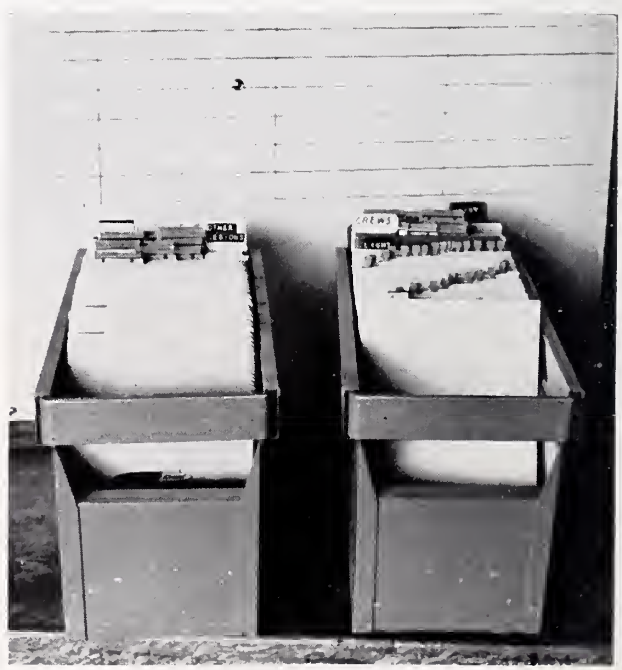

Figure 2.—Tub files can be used to store up to 2,000 cards if the number of items becomes too large for all of the cards to be displayed.

PRECOOKED FROZEN MEALS FOR FIREFIGHTERS

Arthur H. Jukkala, *Forester*
Missoula Equipment Development Center

During the 1967 fire season, many firefighters in the Northern and Intermountain Regions enjoyed hot meals prepared by excellent chefs in modern kitchens hundreds of miles away. This was made possible by several years of testing of military and commercial meals by the Forest Service Equipment Development Center in Missoula.

In the fall of 1965, the Center and the Armour Company began work on precooked frozen meals for firefighters. These meals contain U.S. Choice meats, or Grade A fish and poultry. Menus are scientifically selected in Armour's basic foods laboratory and are prepared by expert chefs. After cooking, the individual food items are vacuum sealed and flash frozen to –70° F.—a big factor in retaining flavor. Before being served, the meals require only heating in boiling water or steam.

Several hundred of these meals were tested during the summer of 1966. Very favorable results were obtained. A larger quantity was ordered for the following season, and in 1967 about 16,000 meals were eaten by personnel of Forest Service Regions 1 and 4 and the Bureau of Land Management—both in firecamps and on the fireline.

In 1967 the following menus were tested:

Breakfast	*Dinner menu 1*	*Dinner menu 2*
Canadian bacon	Sliced roast beef with gravy	Sirloin beef tips with mushroom gravy
Sliced fried potatoes	Peas with butter sauce	Peas with butter sauce
Cherry compote	Bread (3 slices), buttered	Bread (3 slices), buttered
French toast (4 slices)	Potato tots (deep fried)	Potato tots (deep fried)

Meals were packed 12 per case in an insulated carton (fig. 1). Beverages and desserts were not included. Cups, serving trays, and utensils were packed with the meals. Each meal had 1,500-2,000 calories and weighed about 1½ pounds. The aveage cost was $2.70.

At 0° F., the storage life is 2 years. When removed from the freezer, the meals should be eaten within 36 hours (recommended for Forest Service use.) MEDC engineers devised a simple steam heater from a 32-gallon G. I. can. It will hold 33 meals (fig. 2). In field tests the heater proved very practical and efficient.

Figure 1.—Twelve individually vacuum-sealed, precooked meals.

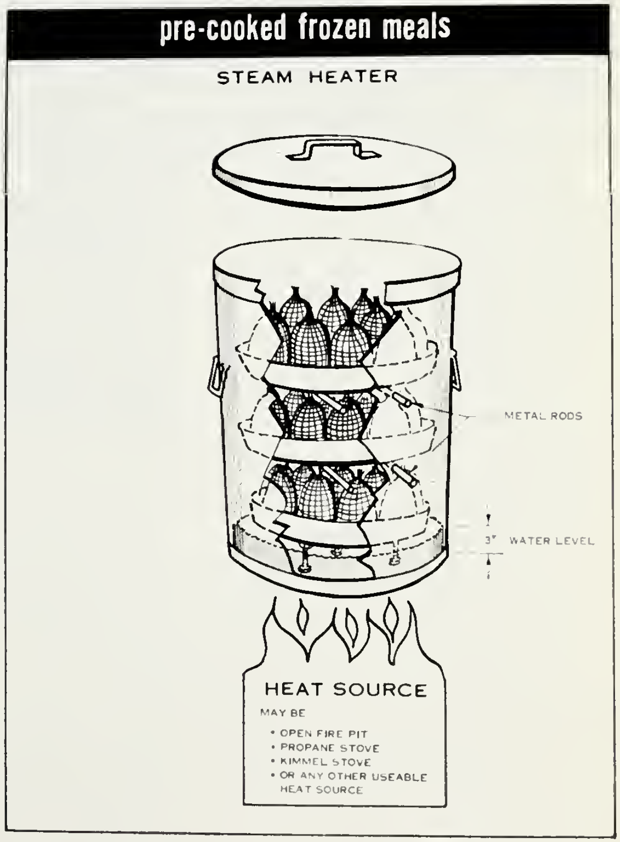

Figure 2.—Steam heater for precooked frozen meals.

Precooked frozen meals have many advantages for feeding firefighters. Since they are packaged in proper proportions, there is little or no waste.

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PENNSYLVANIA'S NEW CUSTOM-BUILT FOREST FIRE TRUCK

E. F. McNamara, *Chief*
Division of Forest Protection
Department of Forests and Waters

The Pennsylvania Department of Forests and Waters received 10 custom-built forest fire trucks in early 1967. These trucks were received as a result of 4 years of work with manufacturers of specialized firefighting equipment (fig. 1).

The chassis is a 1-ton military power wagon with a custom-built body. The standards and design were developed by personnel of the Division of Forest Protection in cooperation with personnel of the Automotive Bureau, Pennsylvania Department of Property and Supplies. Each truck is equipped with the following:

1 300-gal. tank
1 Hale model 20T pump
1 Hale model FZZ pump
300 Ft. of ¾-in. hose on live reel
500 Ft. of 1½-in hose (rolled)
2 Hose laying platforms
1 ¾-in. nozzle
1 1½-in. nozzle
3 10-ft. sections of 2½-in. suction hose
1 10-ft. section of 2-in. suction hose
Miscellaneous hose adapter, connections, and valves
8 Backpack pumps
1 Chain saw
12 Fire rakes
2 Shorthandled shovels
3 Axes
1 Brush hook
3 Sandvig brush axes
1 Backfire torch

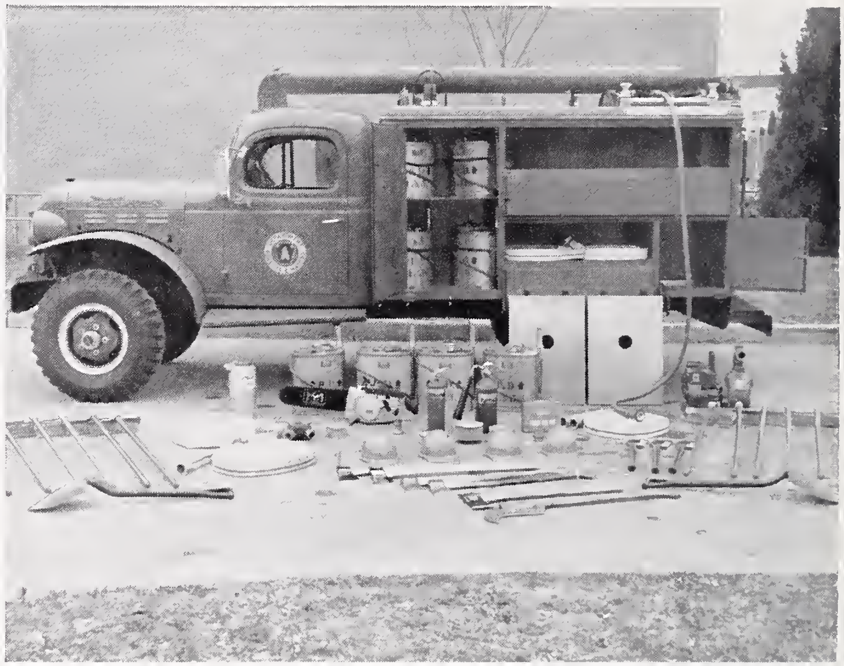

Figure 1.—The new trucks easily carry an assortment of firefighting equipment and 300 gallons of water.

4 Hardhats
2 Fire extinguishers (CO2 and dry powder)
1 First aid kit
1 Dual-frequency radio transmitter

The vehicles are painted red and are equipped with warning lights. The custom body is made of 16-gage steel, with 11-gage steel bottoms in the tool compartments. The interior of the compartments have wooden slats on the bottom to protect the handtools.

The hard suction hose is carried in an easily removable hose rack mounted on top of the truck. The spare tire is located on the top of the 300-gal. tank. Two portable spotlights are recessed in rear compartments.

Each of the vehicles has been assigned to a high fire hazard area. The units will respond to any fire call in areas with limited volunteer fire company coverage.

The easily identifiable trucks, readily available for all fire calls, are definite fire-prevention assets and comprise an effective fire-suppression unit.

SIMULATING PRESCRIBED FIRES—A NEW TRAINING TECHNIQUE

Robert W. Cooper[1] and Archer D. Smith[2]

Prescribed burning, now an important forest management tool in much of the United States, requires an adequate supply of trained personnel if we are to realize maximum potential from its use. In past years, however, difficulty in scheduling field exercises during favorable burning weather has limited development of competent trained forces.

The principle of simulation seemed to provide a partial answer to this training problem. In 1966 for the Forest Service-conducted research seminars in prescribed fire at the Southern Forest Fire Laboratory, we decided to use the Fire Control Simulator[3] for the important burning exercises (essential supplements to classroom sessions). The Forest Service Simulator was sent to the Laboratory at Macon, Ga., and Forest Service Southeastern Area and Southern Region personnel developed prescribed fire exercises.

The results justified the effort. Simulation of prescribed fire bridged the gap between classroom and field. After hearing general principles in seminar, trainees were divided into burning and critique teams and faced with a variety of burning situations under certain fuel and weather combinations (fig. 1). Weather was no problem—it was created as needed. Ground rules were laid down, and slides of the problem area and closeups of fuel conditions were projected on the screen. Trainees were also given a sketched map (fig. 2) and briefed on the situation. The burning team's role was to consider and decide on feasibility of burning, proper firing techniques, advance preparations, and control strategy. A day's burning schedule, including planning, preparation, execution, and evaluation, was compressed into a 1-hour exercise through a fast clock—where 15 minutes of exercise time equaled 1½ hours of fuel time. Upon completing the exercise, the burning team conducted an evaluation and critique.

Figure 1.—Trainees make decisions concerning the prescribed burning operation as they observe fire behavior and strategy on the Simulator screen.

The burning team maintained radio communication with the dispatcher and the field crew (Simulator crew) and had a view of the field operations throughout (fig. 3). For training purposes, the dispatcher and the field crew could not contact each other directly.

To keep the exercise moving and to force prompt decisions, the dispatcher and Simulator crew generally ended radio messages with a question. All decisions and instructions were simulated without regard to their applicability. Initial anxiety of the Simulator team about their ability to respond to directives quickly disappeared. As they gained experience and confidence in simulating prescribed burns, they were able to follow dictated actions promptly and precisely, as well as to enliven the exercise with additional stress situations.

The critique team watched from the rear and, after the evaluation and critique by the burning team, discussed the exercise and the decisions made. The Simulator director, or a designate, led the critique. No comments or suggestions were per-

[1] Research Forester, Southern Forest Fire Laboratory, Macon, Ga. The Laboratory is administered by the Southeastern Forest Experiment Station, Asheville, N.C.

[2] Forester, Southeastern Area, State and Private Forestry, Atlanta, Ga.

[3] O'Neal, N. C., and Holtby, B. E. The fire control simulator. Fire Control Notes 24(2): 25–31. 1963.

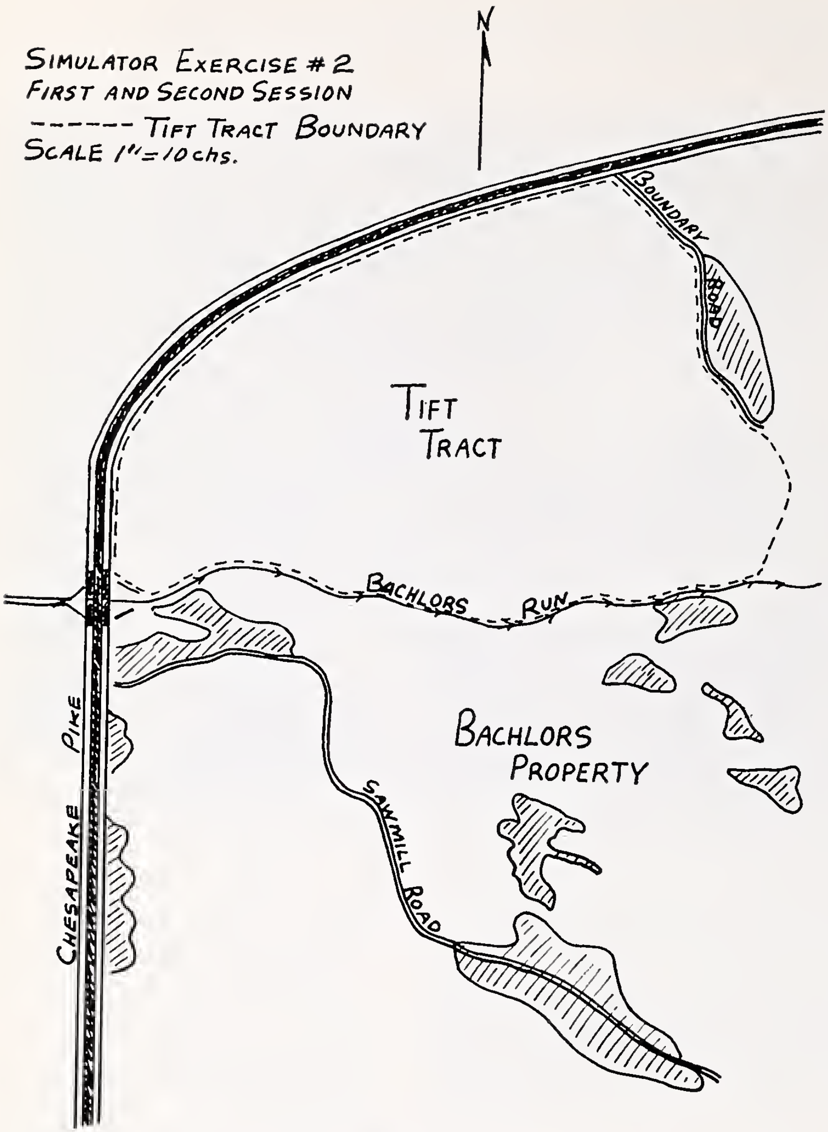

Figure 2.—Sketch of company's holdings (Tift tract) used in prescribed fire exercise.

mitted by the critique team while the exercise was in progress.

The following script is a sample exercise:

SIMULATOR PROBLEM

Hardwood Control—Seedbed Preparation

You are a forester with the Dry Branch Paper Company and are responsible for planning and conducting prescription burns on its land. Your right-hand man is a technician who does most of the field burning under your guidance. In this year's work schedule, a tract of forest land has been set for spring burning. It is now the last week of April. The tract is in southeastern Virginia. It supports a merchantable stand of loblolly pine ready for harvesting, but also has a well-stocked understory of undesirable hardwoods. Regeneration will be by the seed-tree method. You have decided a burn for hardwood control and seedbed preparation is needed before cutting. Today you are in a tower overlooking the area to be burned. You have asked your technician to check it and be prepared to burn if things agree with yesterday's favorable weather forecast. The tract is flat with gentle hills. Free of fire for at least 10 years, it has mostly pine litter fuel—moderate to heavy, 5 tons per acre—with only minor herbaceous material available for additional fuel. The cast of characters includes the forester, technician, dispatcher, and TSI crew leader.

Scene 1: (Explain scale, direction; hand out map. Slides 2, 3, and 4 show aerial oblique and closeup shots.)

Set clock: (It is now 10 a.m.)

Start Exercise

Technician to Forester—This is Al. We'll reach the Tift tract about 10 a.m. You asked me to check in with you before we start any burning. What are your orders?

Fade in Scene 1

Forester—(Would probably ask for onsite weather and fuel conditions. Should check with dispatcher concerning weather—may call technician and tell him where to put lines).

Dispatcher—According to this morning's forecast, we should have northwesterly winds about 8 m.p.h. Afternoon, clear skies, maximum temperature 68° F., minimum relative humidity 35 percent, estimated fuel moisture 10 percent, buildup index 16, and spread index 12. I think this may be the day you've been waiting for. You asked that I send three men and a tractor operator with the technician. Our other four men are out on Jackson's Flat doing TSI. Our other tractor is at headquarters.

Technician to Forester—Things look pretty good. Most of the dew is gone. Winds in the stand are light, mostly from the west—doesn't look like they'll be any problem. It's clear and the air feels dry. What do you want us to do? (If so, where?)

Forester—Yes, I think things look okay. We can go ahead with

Figure 3.—Closeup slides of fuel conditions and firing techniques kept viewers abreast of onsite developments.

the operation. (He proceeds to tell the technician where to put the lines or whatever he wants done, and how to fire.)

Dispatcher to Forester—You remember that Sug was replacing the tracks on our other tractor. He reports that it's ready to go now, but wonders whether he should make the 100-hour overhaul today while the Cat is in the shop.

Forester—(Should say no—keep it on standby).

Dispatcher—TSI crew just called in and said that the surface wind had picked up on their area to the extent that the mist blower wasn't doing much good. I told them to secure operations there and move over to Route 49 where Freeman is grading—there are some culverts there that need cleaning out. Okay?

Forester—Okay. (Might suggest to dispatcher that he keep in touch with this crew in case it's needed. Probably should ask for a later weather report. If asked for forecast, dispatcher will say that he hasn't anything beyond the 10 a.m. prediction—should he ask for a special forecast? Forester should say yes. Special forecast should indicate winds of 10, gusts to 15.)

Forester—(Should call technician and tell him about the special forecast; ask him how the fire is doing. If forester doesn't ask for forecast, technician should call in.)

Technician to Forester—Looks like the wind is picking up here. Has the forecast changed?

Forester—(In one way or the other, he gets special forecast from dispatcher).

Technician—This wind has really started to blow. My strips are beginning to crown—we may have trouble.

Technician to Forester—That last strip jumped. We've got something going in Bachlors Plantation (6-years old) and it may give us a run.

Forester—(Probably will ask technician if he can manage it or whether he needs help.)

Technician—Think we need help. Is the other tractor ready to go?

Forester — Believe so — will have dispatcher get it on its way right now. Do you want the crew, too?

Technician—Yup, looks like we can use 'em.

Forester—Crew is on its way.

Technician to Forester—We may be able to plow around this spot before it moves out or we might better go back to the sawmill road, plow it out, and backfire from there. What do you think?

Forester—(Makes a decision on plowing and firing technique.)

TSI Crew Leader to Forester—This is Ernie. We're here on the Tift with the TSI Crew and the tractor. What do you want us to do?

Forester—(Gives orders to TSI crew leader.)

Control Action Is Successful!

Technician or TSI Crew Leader to Forester—Fire is controlled! What about mopup and patrol?

Forester—(Suggests action.)

Exercise Complete

The prescribed burner has had to learn his trade the hard way. As with the wildfire control specialist before the days of the Simulator, this has required years of experience and sometimes in-

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INDEX, 1967

U. S. DEPARTMENT OF AGRICULTURE
WASHINGTON. D. C. 20250

OFFICIAL BUSINESS

U. S. DEPARTMENT OF AGRICULTURE
POSTAGE AND FEES PAID

Brush in Southern California—*Continued from page 6*

reducing the fuel hazard outside his residence as well as inside it.

CONCLUSIONS

Well, what about brush? We enjoy seeing the chamise fields in full bloom, in smelling the pungent fragrance of sagebrush on a summer's day, and in watching the dark green scrub oak reclothe the bare hillsides following fires. But this brush-covered watershed is undoubtedly the most treacherous forest fuel known to man. Under some conditions the chaparral is virtually impossible to ignite; under other conditions a tiny spark can turn it into a nuclear bomblike holocaust.

In conclusion, there is no single, simple, inexpensive way to solve the southern California brush problem. Prescribed burning may be appropriate under some fuel and weather conditions. But it is generally too risky, and the results are unpredictable. Low-growing and slow-burning plants may also be promising. But they must compete with the hardy natives and withstand the ravages of drought and animals. Selective fuel modification (fuel-breaks) along roads, around residential areas, and on ridgetops and in canyon bottoms appears to hold the most promise at present. Meanwhile, much more research needs to be done to obtain the best solution to the overall problem of chaparral management in southern California.

Meals For Firefighters—*Continued from page 9*

Needs are easily estimated. Since the food is free of bacteria and is not touched during preparation, contamination is unlikely. Labor and equipment needed for preparation are minimal; the meals can be served easily, even on the fireline. Transportation costs, particularly by air, are reduced because meals are light and compact.

Precooked frozen meals cannot replace all methods now used for feeding firefighters. But they do offer a method for furnishing hot, well-balanced, tasty meals quickly, easily, and economically.

Improvements planned for the 1968 fire season include a serving tray with compartments and the addition of frozen juice, desert, instant coffee, and powdered milk. Three breakfast and six dinner menus will be offered.

Training Technique—*Continued from page 13*

volved costly mistakes. When training burns were scheduled the weather all too often failed to cooperate and little was accomplished.

Simulation now offers an excellent method for quick, inexpensive, and realistic training in the use of prescribed burning. As simulation technology improves, training procedures will be refined.

Fire Simulators are becoming available in most of the United States, with State forestry agencies assembling their own units and intending to make them accessible to interested parties. Instead of outdoor training sessions at the mercy of the weather, we can now by means of simulation create our own weather to fit the training need. Hundreds of fire control personnel have experienced lifelike situations in handling wildfire through simulation. The same opportunity exists for prescribed fire training, and use of the Simulator for this purpose will enable better advantage to be taken of its capabilities.

FIRE CONTROL NOTES

U.S. DEPARTMENT OF AGRICULTURE/FOREST SERVICE/APRIL 1968/VOL. 29, NO. 2

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

COVER—Slash reduction using a rolling chopper on the Medicine Bow National Forest. See story on page 7.

(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)

FIRE CONTROL NOTES is issued by the Forest Service of the United States Department of Agriculture, Washington, D.C. The matter contained herein is published by the direction of the Secretary of Agriculture as administrative information required for the proper transaction of the public business. Use of funds for printing this publication approved by the Director of the Bureau of the Budget (Sept. 16, 1963).

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A BREAKTHROUGH IN EFFECTIVE LOW-COST FIRE SIMULATION

SOLOMAN ZIMMERMAN, *Electronics Engineer*
Forest Service Electronics Center
Beltsville, Md.

The value of simulation as a fire control training aid is well established. This realistic "classroom" method of portraying the variety of problems encountered in actual fire situations has been widely accepted. Personnel from Federal, State, and local protection organizations have gained extensive experience, and therefore knowledge, during simulated fire exercises. The initial development of fire control simulators has been basically oriented toward the larger "command" models.[1] By using these sophisticated simulators, with elaborate optical, communication, and sound systems, trainees are placed in a realistic, complex fire management situation.

However, the command models are expensive, and many problems have been encountered in developing a system capability. This has limited to seven the number the U.S. Forest Service has been able to procure. Also, except for one trailer-mounted system, these simulators are difficult to disassemble and reassemble; therefore, they are not easy to move from place to place. Because of these disadvantages, the number of personnel who have been able to receive simulator training has necessarily been limited. Generally, only personnel operating in the higher positions in the large fire suppression organization could be accommodated.

Because the Forest Service recognizes that simulation is an effective training device for all fire control personnel, it has been investigating the feasibility of developing an effective, low-cost model for several years. General criteria for the proposed system have been: (1) Cost of less than $2,000; (2) weight of less than 200 pounds; (3) simulation capabilities to produce changes in fire and smoke patterns, smoke motion effect, and char; (4) a one- or two-channel communications network; (5) and a background sound effects system. Desirable, unessential features included the capability to show fire motion and a symbol effect to portray fireline construction.

The Beltsville Portable Simulator recently developed at the Forest Service Electronics Center meets all these criteria. Preliminary evaluation of its capabilities and performance indicates that the system has the potential to greatly increase the amount of simulator training which can be carried out.

The total cost of the prototype model is approximately $1,000. The components weigh less than 175 pounds. When disassembled, it can be carried by one man and then transported in a station wagon. Assembly and operation of the system is uncomplicated and easily learned. Simulation of fire, smoke, and char effects is excellent, and is completely manageable. Realistic fireline is easily introduced into the scene.

The heart of the Beltsville system is a set of three overhead projectors. The first is used for fire, the second for smoke, and the third for the background scene, char, and fireline or other symbols (fig. 1). A rearview screen projection is used. The operators and all equipment are in a curtained enclosure behind the screen, out of sight of the trainees. With rearview projection, total darkness is not required; exercises can be conducted in a room where direct outside light is subdued.

The fire projector has a dark orange filter covering the writing stage. The filter is covered by a sheet of opaque Vu-Graph film. As the film is scraped away with a stylus, the filtered light is transmitted through the opening and appears on the screen. By controlling the size, shape, and location of the opening, a fire of the desired size and shape is created at the appropriate location on the background scene. Smoke is created similarly by a second projector without a colored filter.

The illusion of motion and direction of movement is imparted to the smoke and flame projec-

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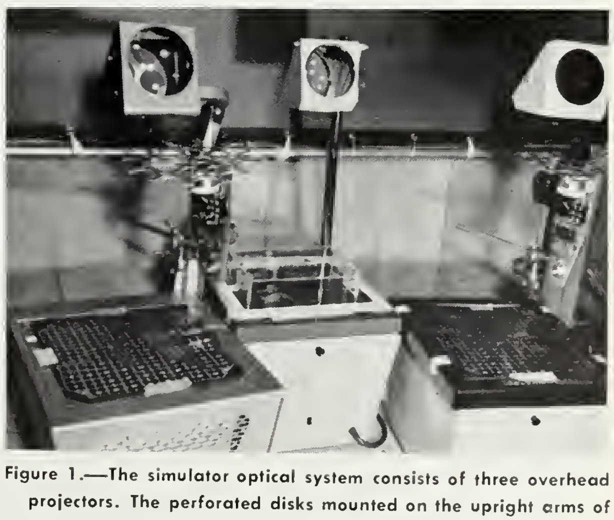

Figure 1.—The simulator optical system consists of three overhead projectors. The perforated disks mounted on the upright arms of the projectors on the left and right revolve to give the motion effect to fire and smoke simulation.

[1] O'Neal, N. C., and Holtby, B. E. The fire control simulator. Fire Control Notes 24(2): 25-31. 1963.

A PRELIMINARY REPORT ON THE INFRARED LIGHTNING FIRE PATROL STUDY

B. JOHN LOSENSKY, *Research Forester*[1]

Intermountain Forest and Range Experiment Station

The key to efficient fire suppression is early detection. Between 1940 and 1949, in U.S. Forest Service Region 1, holdover fires[2] that reached the D and E size classes (burning more than 99 and more than 299 acres, respectively) accounted for 41 percent of the total acreage burned, although representing only 0.13 percent of the total fires.[3] Thus early detection could substantially reduce the total acreage burned.

Forest Service aerial patrols are obtaining faster detection; however, holdover fires have not decreased proportionately. Analysis of 4,073 lightning fires in Region 1 between 1960-65 indicates that 45 percent burned more than 8 hours before discovery. Infrared scanners may be effective in reducing holdover fires. These scanners detect fires from heat radiation rather than by visual means and are therefore usable at night as well as by day.

INFRARED STUDIES

Research in infrared fire detection started at the Northern Forest Fire Laboratory in 1962. Tests in eight major western timber types related infrared detection probability (the number of fires detected expressed as a percent of the total scanned) to such variables as canopy cover, scan angle,[4] and fire size. From the data collected, the major timber types of the Western United States have been grouped into three general detection probability classes (fig. 1). The curves will be used for planning detection flights.

An infrared patrol study was started during the 1966 fire season to scan lightning fires under natural conditions following thunderstorm activity. The study was aimed to find some answers to questions associated with an operational infrared detection system. For example:

1. Do ground conditions affect detection probability?
2. Do all lightning fires provide enough radiation for detection?
3. Are the detection probability classes assigned to the various timber types valid?

Two areas with high lightning occurrence were selected for patrol tests:

1. Montana-Idaho test area—located between latitudes 45°20′ N. and 47°00′ N. and longitude 114°25″ W. and 115°35″ W.—including parts of the Bitterroot, Clearwater, Lolo, Nezperce, and St. Joe National Forests (fig. 2).
2. Oregon test area—including parts of the Wallowa-Whitman, Umatilla, and Malheur National Forests. No usable data were obtained from the area, and it will not be discussed in this report.

STUDY PROCEDURES

The Montana-Idaho test area was divided into strips 8 miles wide and 100 miles long. Flying at 15,000 feet over terrain provided 10-mile-wide coverage and permitted 1-mile overlap on each edge. To fly large areas with a minimum of overlap or gaps between strips requires highly sophis-

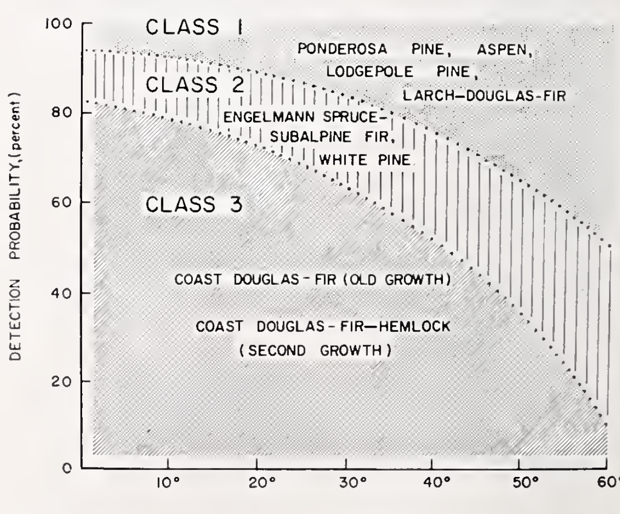

Figure 1.—Infrared detection probability classes. On the basis of individual probability curves for each timber type, generalized class groupings indicate results that may be expected. Scan angle has definite influence in most timber types but relatively little in ponderosa pine. In class 3 types, the infrared method is not likely to be an improvement on conventional methods.

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[1] Stationed at Northern Forest Fire Laboratory, Missoula, Mont.

[2] Here defined as fires not detected within 8 hours after origin.

[3] Data on fires based on Individual Fire Reports (form 5100-29) submitted by U.S. Forest Service personnel. These reports include estimated time of origin, discovery time by conventional detection methods, position, size, etc.

[4] Scan angle—the angle expressed in degrees between the vertical nadir and line of sight from scanner to observation point.

ticated navigation. A Doppler radar system measured true groundspeed and drift angle of the aircraft. Heading was obtained from the aircraft compass. From this information a computer continuously supplied the latitude and longitude of the plane. After lightning occurrence in the test area, night patrol missions were flown as soon as weather conditions permitted. So that there would be no unnecessary flying, the extent of daily thunderstorms was determined from Polaroid slides of the weather radar display obtained from the U.S. Weather Bureau in Missoula. This data—together with reports from each forest on estimated time of lightning occurrence, general area affected, and relative storm intensity (light, moderate, or severe)—was placed on an overlay of the patrol zone. As determined from the overlay, only the segments of the strips affected by lightning were flown.

A continuous strip picture was taken of the infrared imagery on Hyscan Plestar film and was developed with a rapid processor. At the beginning and end of each strip a slate unit, including a clock face, was photographed on the edge of the imagery and discovery time determined. Developed film was available for any point on the ground about 3 minutes after the point was scanned. Rapid film processing provided control of image quality, and allowed us to check the navigation system by comparing the imagery with aerial photos and determining aircraft position. No attempt was made to locate possible targets on the film until the flight was completed.

The imagery was read at the end of the mission, and targets were reported to the forests affected (fig. 3). The forests in turn reported any fires they had found in the test area.

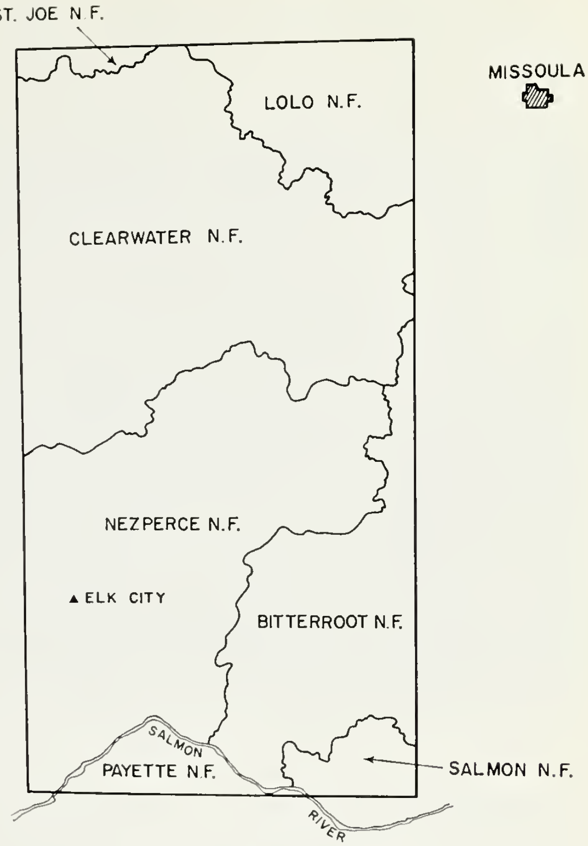

Figure 2.—Montana-Idaho test area.

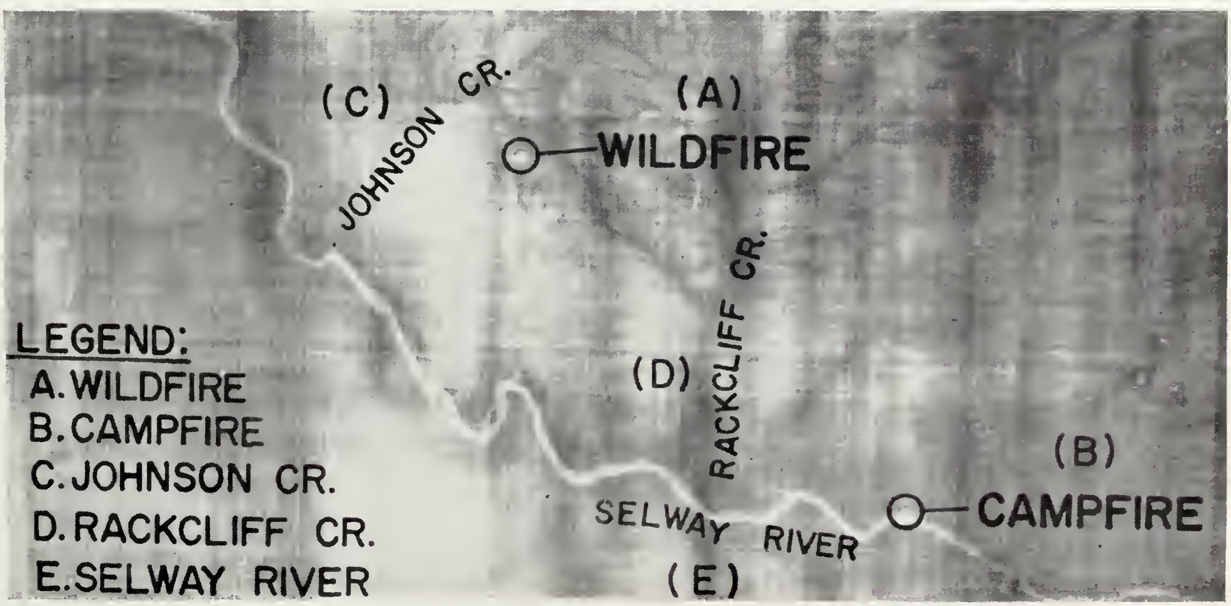

Figure 3.—Infrared imagery showing a wildfire and ground detail.

In the analysis of infrared imagery, an estimate of the fire conditions was attempted as they were when the fire was scanned; also considered were fire size, position (on the ground or in a tree), and heat radiation from the fire. In addition, slope aspect, species composition, and density of the vegetative overstory were estimated to determine their effect on infrared detection. These data were obtained from the Individual Fire Reports, information supplied by the districts, and Fire Laboratory personnel investigating the accessible fires.

RESULTS OF FIRE SCANNING

Seven missions were flown on the Montana-Idaho test area between July 31 and Aug. 15, 1966. Sixty-three targets were scanned and may be classified as follows:

Detected	
Campfires	29
Dwellings	9
Slash Fires	4
Wildfires	12
Subtotal	54
Undetected	
Wildfires	9
Total	63

Of the 12 detected wildfires, four have not been considered in the analysis because of their size; each was larger than one-half of an acre and therefore not a detection problem. The remaining eight are examples of typical lightning holdover fires. Following is a tabulation of fires detected by infrared, showing the lapsed time between origin and infrared detection. These values are compared with the lapsed time for conventional detection. (For example, fire 1 was detected by infrared 8 hours after starting, but it had burned 21 hours before discovery by conventional methods.)

Fire	Lapsed time between origin and infrared scanning	Lapsed time between origin and conventional detection
	(Hours)	*(Hours)*
1	8	21
2	11	24
3	13	17
4 (estimated)	16	Fire went out before found
5	51	50
6	51	15
7	47	40
8	30	13

Fires 1 through 4 were found earlier with infrared; fires 5 through 8 were found earlier with conventional methods. All fires were detected with infrared the first time they were scanned. The lapsed time for infrared detection probably could have been reduced, especially for fires 5 through 8, if flights had followed more closely upon the storms from which the fires originated. Delays were caused primarily by scheduling problems that can be corrected in future testing.

Nine fires were scanned but not detected by infrared; eight of these may be classed as holdover fires. They were discovered by conventional methods from 12 hours to 48 days after origin. Following is a tabulation of fires scanned but not detected by infrared, showing the lapsed time between origin and scanning. The lapsed time between origin and detection by conventional methods is also shown. (For example, fire 9 was scanned but not detected by infrared 52 hours after it started. It was discovered by conventional methods 4½ days after it started.)

Fire	Lapsed time between origin and infrared scanning	Lapsed time between origin and conventional detection
9	52 hours	4½ days
10	12 hours and 31 hours	71 hours
11	17 hours	24 hours
12	6 days	20 days
13	50 hours	5½ days
14	8 hours and 32 hours	49 hours
15	6 days, 17 days, and 18 days	29½ days
16	6 days, 17 days, 18 days and 38 days	47½ days
17	9 hours	1 hour

DISCUSSION

Some questions posed at the outset were answered, although much remains to be investigated.

Detection probability.—Present indications are that ground conditions, such as slope, aspect, and fire location on the slope, do not adversely affect infrared detection probability. Validation of detection probability classes cannot be made because of the small number of fires scanned in a wide variety of timber types. However, 55 percent scanned at angles greater than 40° were detected. This percent agrees with data obtained from the detection probability study.

Radiation.—Reliable data are not available on whether or not all the fires scanned radiated enough heat for detection, because determining the exact character of the fires at the time they

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DISPOSAL OF LOGGING SLASH WITH A "ROLLING CHOPPER"

S. H. VAN and DALE G. GALLAGHER[1]

After an area has been logged, the land manager is faced with the problem of the many treetops, limbs, small unmerchantable trees, and other debris which remain. It is often necessary to reduce this slash for fire control, mistletoe control, aesthetics, and other reasons. Since little, if any, of the material can be economically utilized, other treatment measures are usually required. The method most commonly employed is burning. However, in recent years a "rolling chopper" has been successfully used in some areas. Treatment of slash by the chopper has proven to be less expensive, and has offered several other advantages over other treatment measures.

Figure 1.—Rolling chopper used in lodgepole pine slash disposal on the Medicine Bow National Forest.

EQUIPMENT

The chopper is a hollow-steel cylinder, with cutting blades on the rolling surface. The model shown in figure 1 is 12 feet wide and has a drum diameter of 5 feet. The blades are 10 inches high, and they are spaced 21 inches between cutting surfaces. When empty, the chopper weighs 18,500 pounds, but when filled with water, it weighs 32,100 pounds.

The chopper is pulled by a late-model crawler tractor, usually in the D-7 or D-8 class. It costs approximately $6,500 to $8,000, depending upon the specific model and freight charges.

UTILIZATION

The chopper can be used on slopes of up to 20 percent where conditions are favorable. It cannot operate in areas that are swampy or where there are numerous rock outcrops.

The cutter is able to treat an average of 12 to 15 acres per 8-hour day, at a cost of $10 to $15 per acre. This cost figure includes overhead, amortization or rental of the equipment, hauling of the equipment, repairs, etc.

Because use of the chopper will destroy any residual stand on an area, it cannot be employed where it is desirable to save advanced reproduction. However, since mistletoe is often a problem in lodgepole pine, elimination of the residuals is often an advantage there.

RESULTS

Limbs and treetops are broken and partially buried in the soil by the cutter. Larger material, up to 7 inches in diameter, is broken, shattered, or sliced. In addition to this action, the blades also make small furrows in the soil, reducing the potential for erosion and preparing a good seedbed.

Figure 2 shows a logged area before any treatment. This timber stand was mature, even-aged lodgepole pine *(Pinus contorta)*. It was clearcut to a tree diameter of 8 inches. Figure 3 shows a typical area after the "rolling cutter" has made one pass over the debris.

ADVANTAGES

There are a number of advantages to using a chopper for treatment of logging slash in lodgepole pine. These also would be applicable to similar timber types.

1. The chopper can be used anytime after the site has dried out, whereas burning can be done only under certain weather conditions, often delaying needed treatment.
2. The cost of $10 to $15 per acre is less than one-third the cost of piling and burning. The treatment is completed in one operation, and supervision time is also reduced.
3. The slash, which is on the ground or partially buried, de-

[1] Respectively, Timber Staffman and Fire Staffman, Medicine Bow National Forest, Wyo.

composes rapidly. This decomposition returns organic matter to the soil, rather than consuming it as with burning.

4. The furrows in the soil made by the blades provide a good bed to cach and hold tree seed. Those areas treated with a chopper from 1960 to 1963 were found to have naturally established regeneration averaging 1,830 seedlings per acre in a 1966 survey. These furrows also help to hold moisture and reduce runoff and erosion; therefore, there is minimum topsoil disturbance.

5. After chopper treatment, other equipment can traverse the area for thinning, fire control, etc.

6. The chopper-treated area is always more esthetically desirable than untreated areas, and often more desirable than burned areas.

7. Disposal of slash by the chopper method does not affect air pollution.

SUMMARY

Rolling cutters have been used on the Medicine Bow National Forest since 1960. Both smaller tandem units and single, larger choppers have been used. The single, larger unit is easier to maneuver, and maintenance has been cheaper and less frequent.

We have developed the following guides for using a rolling chopper:

1. Use on lodgepole pine areas within 3 years of the timber cutting. Do not use on spruce-fir stands with well-established advanced reproduction, or on lodgepole stands containing more than 2½ cords per acre of residual stand.

2. Use on mistletoe-infected areas.

3. The optimum minimum size area for treatment is approximately 20 acres. This can be a single area, or several smaller units close together.

4. Use on cutover areas with light to heavy slash.

5. Use on slopes of up to 20 percent that are reasonably free of rock outcroppings and swampy areas.

6. Do not use on areas where live or dead snags with a diameter of 10 inches or more exceed 5 per acre.

In summary, the rolling chopper has allowed treatment of more areas of logging slash at less cost per acre. This treatment has not only reduced fire and erosion potential, but also provided better seedbeds with resulting satisfactory natural regeneration.

Figure 2.—Untreated slash on mature, even-aged lodgepole pine clearcut area.

Figure 3.—Lodgepole pine slash after chopper treatment.

IMPROVED BASE FOR OSBORNE FIREFINDERS

Missoula Equipment Development Center

When the lookout's view of a fire is obstructed by a portion of the lookout building, the standard firefinder must be lifted and moved to the alternate set of rails on the base.

An employee suggestion for an improved base, which makes this lifting and moving unnecessary, has been evaluated by MEDC (fig. 1). The new base permits sliding the firefinder to either side without disturbing settings or leveling. It also permits the firefinder to be positioned in locations which would fall between the rails of the standard base.

Paraffin lubrication of the base is recommended. Movement in any direction within the limits of the rails is smooth and positive.

A list of materials follows:

Part number	Part name	Quantity	Item	Dimensions (inches)
1	Base	1	Exterior plywood	¾ x 24 x 24
2	Rail	2	Angle aluminum, ¼" stock	24 x 1¼ x 1¼
3	Slide pipe	2	Steel pipe	11½ x ¾ (1.05" O.D.)
4	Cross rod	2	Steel rod	¾ x 23½
5	Bolt	4	Steel	5/16 x 1 18NC
6	Nut	4	Steel	5/16 18NC

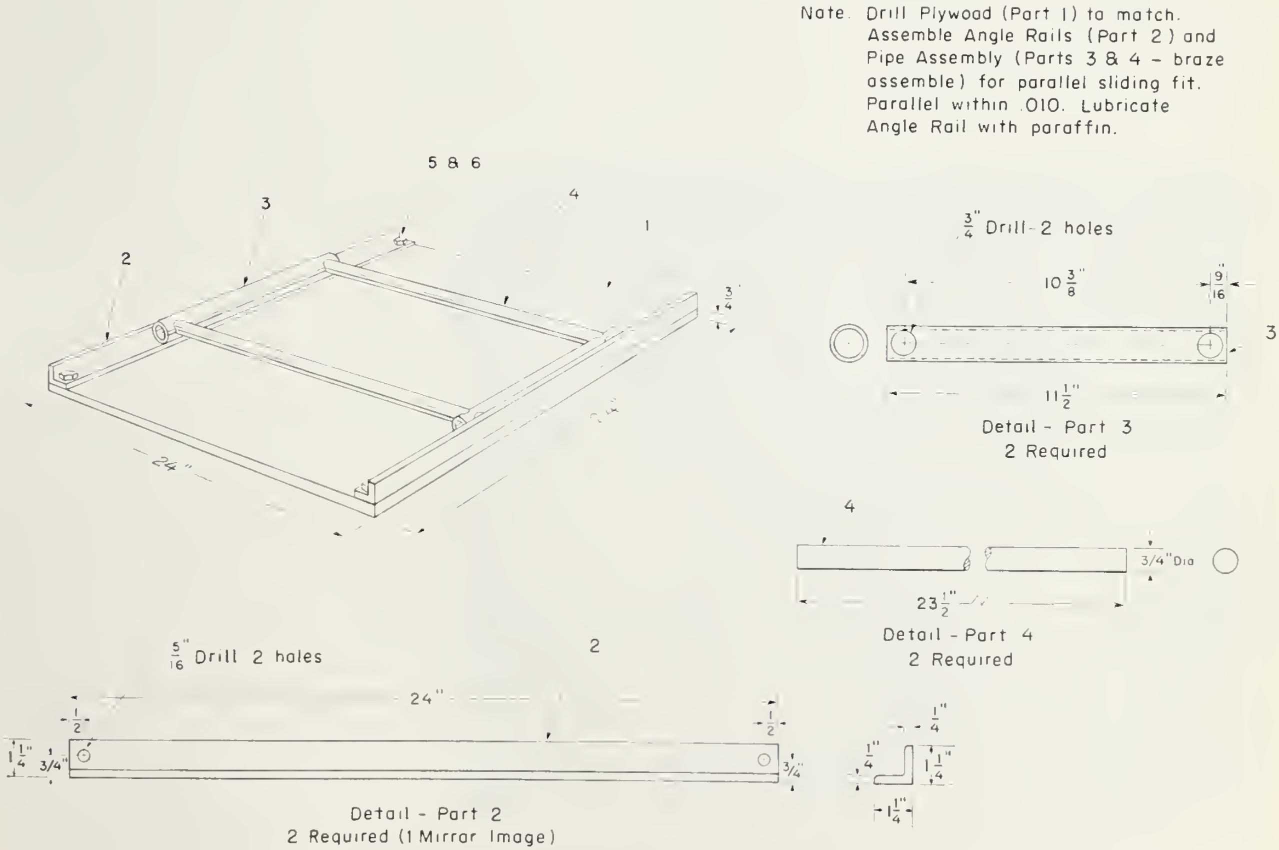

Figure 1.—Construction plan for improved base for the Osborne firefinder.

TIPS ON APPEARING AS SMOKEY BEAR

DAVID C. PHILLIPS
Fire Prevention Specialist
Pike National Forest, Colo.

This report describes the impressions gained during more than 100 impersonations of Smokey Bear within 3 years. These impressions were obtained as Smokey rode a racing car up the Pikes Peak Highway, from publicity photos, and from appearances in parades, in skits with youth groups, in schools for deaf and blind children, and in ordinary schools, etc.

Smokey Bear may be the most universally recognized symbol of fire prevention. He is recognized by young and old, both in this country and in many other nations. (fig. 1) Most people will stop to shake hands and converse with this symbol. Dignitaries, whether political, military, or business, usually welcome a handshake and a few words with Smokey.

The Smokey symbol is not closely identified with any specific organization. Forest Service identification is present, but it is usually secondary to that of the sponsoring organization, i.e., volunteer fire departments, military fire departments, or school administrations. Also, the Forest Service encourages use of the Smokey symbol by all wildland management agencies. Relations with other organizations can be strengthened by inviting uniformed representatives to accompany Smokey.

GENERAL SUGGESTIONS

Fear

Probably the most important suggestion is that the impersonator should be constantly alert for frightened people.

A few adults are frightened by Smokey. Women are affected more often than men. Most adults are startled by Smokey's appearance. Speak carefully to people who are not facing you. Keep as much distance as possible until Smokey has been recognized.

Two- to four-year-old children are usually frightened by Smokey. Only a few 5-year-old children are frightened, and many will come to Smokey if given adequate time. Parents often need to be warned that their child may be alarmed.

Figure 1.—Smokey's friendliness toward children favorably influences children's fire-prevention attitudes.

Reaction of Different Ages

The reaction varies by age. The general reaction pattern is:

0 to 2 years old—This age group usually does not react to Smokey. If children react, it probably will be with fear.

2 to 4 years old—Children often react with panic. It is best to keep some distance from them.

4 years old—Children are very timid. Many cower behind their parents and will not approach Smokey. Stand still and let them walk to you.

5 years old—Most children will approach Smokey and will want to shake his hand.

6 to 8 years old—Children are curious about the suit and try to detect flaws. The impersonator should volunteer the information, "Of course Smokey is a man in a costume." Explain why there is such a costume.

9 to 13 years old—Children are embarrassed to be seen with Smokey. Smokey needs to offer encouragement. It seems best to ask questions and to attempt to establish a teacher-student relationship. It is difficult to control the behavior of a group of boys if rapport is too closely established.

13 to 21 years—This group usually ignores Smokey. Some interesting conversations occur if

groups include both boys and girls.

Adults—Self-confidence is directly correlated with the amount of conversation with Smokey. Conversation should not exceed 30 seconds unless initiated by the other person. Special effort should be made to contact dignitaries.

Attributes of Impersonator

Fewer skills are required to impersonate Smokey while on a parade float than during a question and answer session with a group of sixth-grade students. Summer employees, especially recreation guards who normally contact people, can adequately impersonate Smokey at parades.

At schools the impersonator needs Forest Service experience. He also must have the ability to speak in public and provide suitable answers to the many questions which are asked. The most important need is to like children and to enjoy talking with them.

MEETING PEOPLE

When a large crowd is expected, Smokey must have assistance, for he cannot control those who may press around him and still make effective prevention contacts.

When Smokey shakes hands, he should put his hand where it can be grasped by the other party; he must lower it for small children. Do not grab hands that are extended. For children, it is often effective to ask if they want to pet you rather than shake hands.

Contact with each individual is normally brief. Usually there is only time to shake hands and exchange a word or two. Speak to as many individuals as possible. Some typical comments are: "Isn't this fun to pretend?"; "I have more fun than people."

A specific fire prevention message may be difficult to get across unless time is taken to

Figure 2.—Blind girl "sees" Smokey.

establish rapport. Such a strong impression is made by the Smokey suit itself that it often takes at least 1 minute to gain the necessary attention.

Visits to Handicapped Children

Approach these children slowly. Emotional problems are occasionally associated with physical handicaps. The child, or an adult accompanying the child, will usually indicate the behavior pattern Smokey should follow.

Blind children need to touch Smokey (fig. 2). Encourage the blind children to "see" the entire suit, from the hat to the furry feet. Special interest is created by the ranger's hat, moveable mouth, and the shovel.

Parade Appearances

When Smokey appears on floats, he is usually the main attraction. Simple floats featuring Smokey are effective. Elaborate floats may lose some of their effectiveness to Smokey. Smokey should be at the front of a float so he can be viewed as the float approaches. An unobstructed view of Smokey, which allows the crowd to see him waving to both sides, is most effective.

However, many Forest Service floats are on trucks where it isn't possible to put Smokey at the front of the vehicle. In this case, put Smokey at the rear of the float, facing the direction of travel.

Balance is a problem. A hand hold, or a brace to help keep balance, is essential.

School Appearances

Smokey's appearance at a school assembly is not nearly as effective as his visits to classrooms. In classrooms, close rapport can be established between the children and Smokey if an atmosphere for fun is maintained. Smokey's appearance is effective with or without advance preparation by the class. Smokey is an effective tool when he is used to reinforce material already learned. Clear distinction should be made between the real bear named Smokey and the symbol of Smokey which is in the classroom.

Typical classroom appearances have four steps: (1) Establishment of rapport, (2) explanation of need for Smokey, (3) Smokey's rules and items suggested by local fire department, and (4) a question period. Smokey's appearance must vary from grade to grade and class to class.

THE SUIT

The Smokey suit must be in first-class condition for each appearance. The suit is closely examined by the public, and every flaw detracts from the overall impression. The fur of the suit should be brushed regularly. A hairbrush is adequate. Dry cleaning by a commerical cleaner is satisfactory.

Padding worn under the suit improves the appearance. One approach is to make a "corset" of 1 inch of foam rubber and to pad the seat with 3 more inches. Most impersonators perspire freely in the suit. Lightweight absorbent clothing should be worn.

Continued on page 16

THE LINCOLN HARNESS

ABEL A. ZAMORA, *Electronics Technician*
Lincoln National Forest, N. Mex.

The Lincoln harness (fig. 1) was devised to fill the need for an inexpensive method of simultaneously monitoring Air Net and Forest frequencies and instantly communicating to either while on air observation.

The portable radios, harness, and strap-on antennas make a compact, self-contained kit and enable the operator to fly in any available craft.

The control box is simple to build and parts (fig. 2) are inexpensive, many being available on surplus.

		Cost
P 1	U-93A/U (Military surplus)	
P 101	Microphone plug, Motorola #28A16370	$0.53
P 201	Microphone plug, Motorola #28A16370	.53
J 1	U-92A/U (Military surplus)	
J 2	Microphone jack, Motorola #9B16345	.62
J 3	Phono plug, Motorola #9B54664	.05
S 1	Switch, pushbutton, DPST, Type 35-1 (Allied #56A4964)	1.20
S 2	Switch, rotary, 4-pole, 2-position, Type 3142J (Allied #56A4306)	1.05
S 3	Switch, SPST, miniature	1.10
	Housing, bud type 2102A (Allied #42A7618)	.80

Figure 1.—Air observation scout using Lincoln harness prepares for patrol flight.

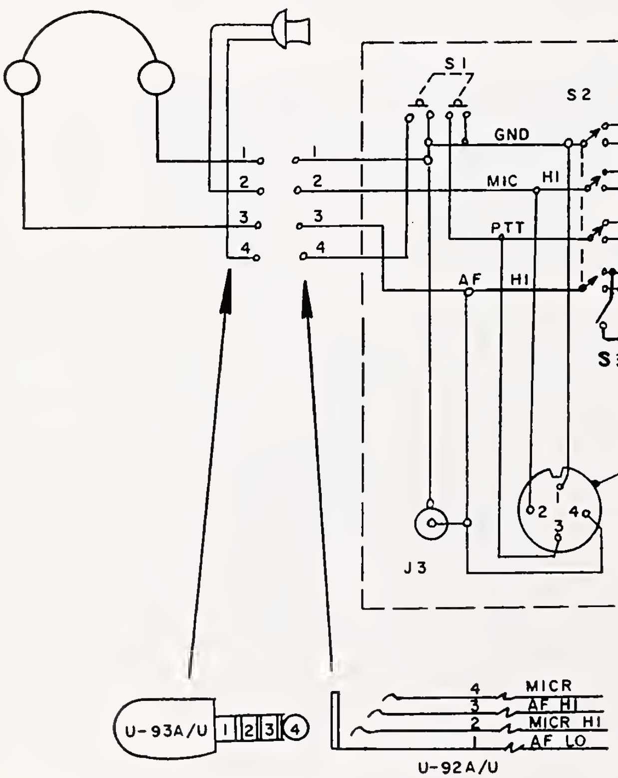

Figure 2.—Wiring diagram and parts for the Lincoln harness are shown.

The harness can be used with a Motorola type NMN6009B headset or with a military headset with carbon microphone preferred by this Forest. It can also be used with a crash helmet headset. Advantages offered by the military headset with carbon microphone include:

1. Cost: The earphones are generally available through surplus as complete headsets including the boom microphone.

2. Flexibility: Government surplus flying helmets with the headset built in are also usually available.

3. Impedance Matching: There is no need for a matching transformer as the earphones offer minimum mismatch to the output transformer. Therefore, audio loss and distortion are negligible.

Though no attempt was made to provide for dual transmission, another pair of earphones can be paralleled for dual reception.

The net selector on the control box (fig. 3) gives the operator a selection of Forest or Air Net frequencies. No provision has been made to switch channels at the control box as this would require modification of the radio units. Channel selection, however, can easily be accomplished due to nearness of the radios to each other and to the operator. The length of the control cables, 6 feet maximum, governs this distance. Normally, most of this length is alongside the operator for comfort in operation.

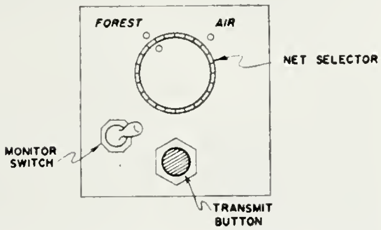

Figure 3.—Control box showing net selector.

The monitor switch provides for reception of both frequencies regardless of net selector setting. To transmit, though, the selector switch must be set to desired service.

The control box is mounted on a pilot's kneeboard. The kneeboards are also usually available on surplus and make an ideal base.

HOOK IMPROVES MOPUP WAND UTILITY

PHILLIP C. HICKS, *Forester*

Rouge River National Forest

The pipe nozzle extension, or wand, in the standard mopup kit is a valuable tool for the efficient use of water. Its use facilitates the direct application of water to the burning material, especially when the material is in hard-to-reach spots such as in deep duff and under logs and debris.

For the most effective use of water, an extra man with a shovel or some other tool usually must work constantly alongside the nozzleman. He turns material over when necessary to expose the burning side. The need for this second man can be reduced, however, by the addition of a small hook to the nozzle end of the wand (fig. 1). This addition makes the wand a light-duty pike pole, and the operator can easily turn small poles and chunks without assistance. Then one shovel man can turn the larger material for two or three wand operators.

Figure 1.—The addition of a small hook to the mopup wand permits the operator to move small material easily without assistance.

The hook is fabricated by welding a pointed steel rod onto a steel ring. The ring is slipped over the wand and held in place just above the nozzle by an Allen screw. When the wand is used for boring into deep duff, the screw is loosened, and the hook assembly is slipped up the wand and refastened out of the way so that it will not hang up on matted roots.

The improved wand was tested during the past summer in Region 6, and it was enthusiastically accepted. The hook has been adopted as a standard accessory for Region 6 mopup kits.

The cost of making each model hook assembly was $3.50. However, when produced in quantity, this figure should be much lower.

A PORTABLE STAND FOR LARGE SMOKEY BEAR SIGNS

NATHAN DAUCHY, *Assistant in Charge, Fire Control*
Vermont Department of of Forests and Parks

The Vermont Department of Forests and Parks has designed a portable stand for use with the large Scotchlite Smokey Bear roadside signs. With this stand, the signs can be moved more often; in turn, they are seen by more people (fig. 1). Two weeks is usually the optimum exposure time for each location.

The stand is constructed of pine and spruce; it has sufficient strength and is light in weight. The base skids are mortised to a depth of 1 inch to hold the feet of the upright frame when the stand is erected. Each foot is secured in place by a lag screw through an iron plate bolted to the foot. (fig. 2). The sign is fastened to the frame by seven screws. Paint on the screw heads makes them inconspicuous. The entire stand is stained dark green.

To prepare the standard for moving, unscrew the two lag screws, raise the uprights to free them from the mortise, and pull the bottom forward; the frame pivots on the back braces. When folded flat, the assembly is about 9 inches high, 56 inches wide, and 96 inches long.

The best location for the sign is on the outside of a curve at the end of a long straightaway. It should be placed a few feet higher than the road, and the background should be woodland. The base can be staked or weighted down to prevent the sign from being blown over by wind. To discourage vandalism, it should be placed near an occupied dwelling.

Figure 1.—This portable stand permits optimum use of Smokey Bear roadside fire prevention signs.

LIST OF MATERIALS

	Item	Quantity	Dimension (inches)
Lumber			
	Base:	2	4 x 6 x 96
		2	2 x 4 x 52
	Braces:	2	2 x 4 x 56
	Frame:	2	2 x 4 x 73
		3	1—⅛ x 4 x 52
		2	1—⅛ x 4 x 60
	Head stay:	1	2 x 4 x 24
Hardware			
	Machine bolts:	2	⅜ x 9
		2	⅜ x 9
		4	¼ x 3
	Lag screws:	2	¼ x 1½
	Screws:	7	3 roundhead iron, 10 ga.
		4	2½ flathead iron, 12 ga.
	Washers:	8	⅜
		4	¼
	Iron plate:	2	⅛ x 3 x 6

Low-Cost Fire Simulation—***Continued from page 3***

tions by motor-driven perforated disks rotating across the paths of the light rays in out-of-focus positions. By varying the speed and direction of rotation, and the location of the disk, the complete ranges of both fire and smoke effects can be obtained. Realistic simulation is very satisfactory over a wide range of background scenes.

A 7½- by 5-inch color Vu-Graph transparency is used for projecting the background scene. The emulsion side of the transparency is protected by an acetate sheet. Firelines and other symbols are drawn directly on this sheet.

Char is put on the scene by shading with a china-marking pencil on a plexiglass char plate set 2 inches above the transparency. Since the pencil and operator's hand cast a shadow on the screen if char is added directly during the exercise, acetate sheets on which the char has been premarked can be quickly positioned on the plate as the burned area increases.

Telephone and radio communications are both provided with the prototype model. Inexpensive equipment is used. The telephone is a simple two-station intercom. The radio network consists of a pair of two-channel Citizen's Band walkie-talkies and a small base station. The base station is modified slightly to reduce power to conform with FCC requirements, and to enable it to be used as a public address amplifier. Two low-priced tape recorders provide a variety of background sound effects, and a third is used to record the exercise for later critique.

The Beltsville Portable Simulator, with its low cost and portability, permits greatly increased use of simulation for training at all levels. While the original concept in the development of a small model was to provide a method for initial-attack training, the system produced has the capabilities to effectively be used for sector size fire training. Only minor additions to the communications equipment are needed to handle more complex situations. Structural fire simulation is also possible; the system may also be used in training urban and suburban fire units.

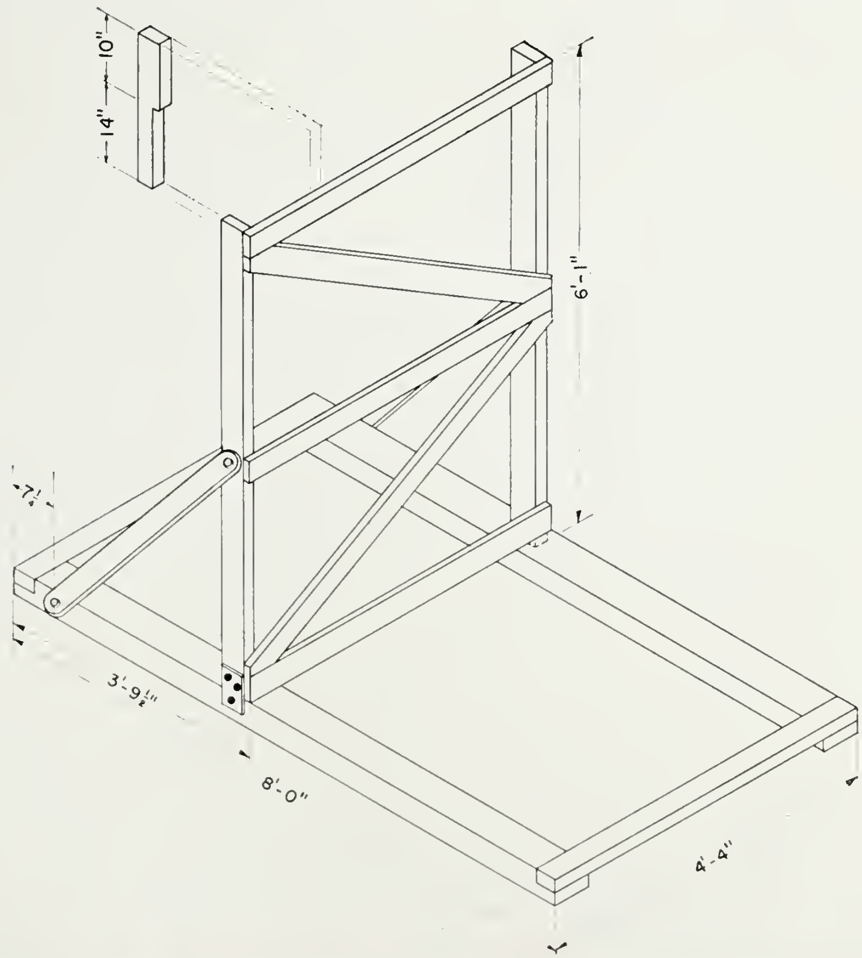

Figure 2.—Isometric plan of a portable stand for large Smokey Bear fire prevention signs.

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Infrared Lightning Fire Patrol Study—
Continued from page 6

were scanned is difficult. We judge that all fires scanned probably had sufficient intensity for detection. The infrared system is almost certain to detect 0.25 square foot of unobscured fire source under these operational conditions.

Fire position (on the ground or in a tree).—An important element previously overlooked by us is fire position. We had assumed that a fire burning near the top of a snag would be easier to detect with infrared than a fire on the ground because obscuration from tree canopies would be less. This study tends to contradict this premise: of four fires (5, 9, 15, and 16) known too be confined to a snag at the time they were scanned, only one was detected with infrared. Examination showed that the three undetected fires were burning inside the snag when observed and the one detected was burning on the outside.

Nature of holdover fires.—Infrared detection probability seems correlated with the time a fire is likely to burn before discovery by conventional means. If the fires scanned are tabulated according to the time they hold over, the following breakdown results.

Time interval between origin and detection by: conventional methods	Fires scanned	Fires detected by infrared	Fires undetected by infrared
(Hours)	*(Number)*	*(Number)*	*(Number)*
8-24	4	3	1
24+	8	0	8

(Fires 5 through 8 are excluded from the tabulation because they were discovered before being scanned and therefore may have been atypical of holdover fires.)

Thus, as proposed by Alan R. Taylor, Associate Research Forester at the Northern Forest Fire Laboratory, the difficulty of detecting holdover fires by any means may be caused by the special nature of such fires; that is, fires that go undetected for extended periods may be those burning within a snag or live tree, and the lapsed time between origin and detection by either infrared or conventional methods may depend in part on when the fires break out onto the exterior or firebrands drop to the ground.

Vegetative cover (timber and brush canopies) and fire position are the most important limiting elements in infrared detection.

CONCLUSIONS AND FUTURE PLANS

Infrared scanners have been shown to detect fires under natural conditions, and sometimes do so sooner than conventional methods. Apparently fire position is more important than was originally thought, and its relation to detection should be studied further. Additional data are needed to evaluate the system in general, and tests on a larger scale were conducted during the 1967 fire season. Data from the 1967 season are now being analyzed, and a report will soon be published. The results appear to be encouraging, and operational testing may be initiated.

Smokey Bear—
Continued from page 11

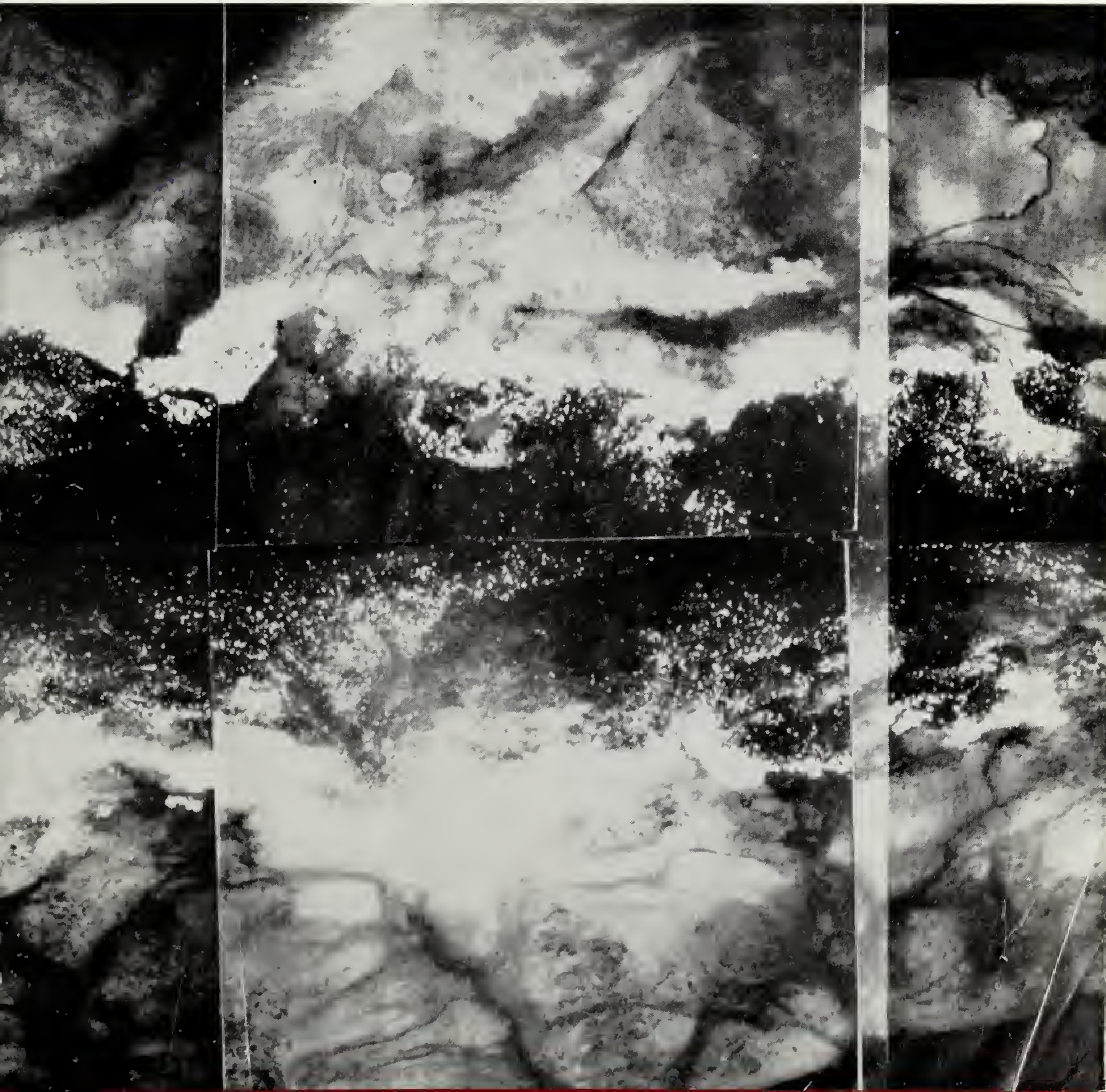
Help is needed to get into the suit because there is a zipper up the back and a drawstring. Before a public appearance, answer the following:

1. Is the drawstring tucked in? 2. Is the zipper out of sight in the hair? 3. Is the belt firmly fastened to the pants? 4. Are the pants cuffs neat? 5. Are the pants long enough to cover Smokey's ankles when he is leaning over a small child? 6. Has the head been set straight on the shoulders?

Most pictures depict Smokey with a shovel. The shovel has become a part of the symbol and should be carried at all times.

FIRE CONTROL NOTES

U.S. DEPARTMENT OF AGRICULTURE/FOREST SERVICE/JULY 1968/VOL. 29, NO. 3



FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

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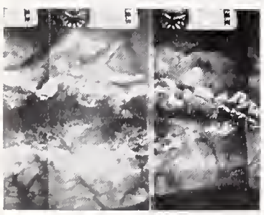

COVER.—Infrared imagery mosaic of a portion of the Sundance Fire, Kaniksu National Forest, Idaho, Sept. 2, 1967. The head of the fire is shown. The fire area is approximately 7 miles long by 3½ miles wide.

(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)

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FIRE HAZARD MANAGEMENT IN THE BITTERROOT— A FURTHER REPORT

JOHN MORRISON, *Forester*
Bitterroot National Forest

In the fall of 1962 the Bitterroot National Forest started developing a hazard management plan for 200,000 acres of high-hazard, over-mature, and insect-killed lodgepole pine stands. Objectives of the plan are to:

1. Minimize the possibility of conflagrations;
2. Salvage available merchantable timber;
3. Reduce the fire hazard; and
4. Return the area to timber production.[1]

The plan was initially implemented in 1963 when 15 helispots and 5 miles of access road were constructed. Three fuel-break areas totalling 160 acres were prepared for burning. Merchantable timber was salvaged, with 10 to 20 lodgepole pine seed trees left per acre. Unmerchantable trees and snags were felled. Burning of these areas in 1964 resulted in a good clean burn with minimum control problems. But there is now insufficient natural regeneration to stock the areas even though seed trees with serotinous cones were left.

Because of the high cost of preparing the areas, and the failure to quickly establish a satisfactory stocking of seedlings, a search was begun for other methods of establishing fuel breaks in the high-hazard, heavy-fuel areas.

THE NEW PLAN

Plans were made to develop strip fuel breaks at two of the largest and most hazardous blocks on the Forest—along the Meadow-Tolan Creeks divide and the Sleeping Child-Skalkaho Creek divide. Each of these planned fuel breaks consists of a continuous strip ¼ to ⅜ mile wide on which all the readily burnable fuels are to be consumed and a young stand of timber re-established. When the young trees reach a height sufficient to shade the ground and close their canopy, the area will become virtually fireproof.

On the merchantable timber types, all salable material will be removed by commercial sale and the residual burned. Non-merchantable areas will be lined and burned to make the break continuous.

Access roads have been built by the timber operators and the Hazard Management Project. The Meadow-Tolan fuel break will be 7 miles long and the Sleeping Child-Skalkaho break will be 8 miles long. Others are being planned.

FOUR METHODS TRIED

In an effort to find an economical way to build the fuel breaks and reforest them naturally, four methods were tried in 1967:

1. In July, half of the standing material on two blocks was laid down using a D-8 dozer working on the contour.

2. On one block *all* standing material was laid down.

3. One block was helicopter-sprayed with one part 2-4-D (4 pounds acid equivalent) to nine parts diesel, at the rate of 10 gallons per acre.

4. Two other blocks were left in their natural state except for control lines.

Exterior firelines approximately one chain wide were constructed with a D-8 dozer. Lines between blocks were one dozer wide. The access road was used for the bottom line on all blocks. Snags that would fall across the road were cut before burning.

The treated blocks were burned on Sept. 18, 1967, and the untreated blocks on Sept. 20 (figs. 1, 2, and 3). All blocks ignited readily and burned well. The sprayed block burned somewhat violently, possibly because flash fuels were supplied by the low shrubs killed by spraying.

SEED FALL IS ADEQUATE

The day after firing, seed traps were placed in all blocks except the 100% laydown block. The traps

(Continued on page 16)

Figure 1.—Untreated area ready to burn.

[1] Morrison, J. Fire hazard management. Fire Control Notes 25(2) 13-15, 1964.

TRAIL BIKES EFFECTIVE IN FOREST FIRE CONTROL

Earle S. Williams, *Forest Ranger*

Maine Forestry Department

A major problem of forest fire control in the "back country" of Maine is making simultaneous and rapid attack on numerous lightning fires resulting from a single storm. Men walking in with hand tools from the nearest road or lakeside have been used in past years.

The increasingly popular use of rough-country motor bikes by recreationists along many abandoned skid roads led to their trial use for firefighters in 1965. After reviewing available equipment, two Trail Breaker bikes were selected which have the following features suitable for forest fire control agencies:

1. Two-wheel drive
2. Good flotation (670x15, 2-ply tires)
3. Ground clearance—15 in.
4. Fording depth—24 in.
5. Transmission ratio 70 to 1 (maneuvers 90% slopes)
6. Adaptability to a variety of ground conditions (swampy areas, rocky and rough areas)
7. High load-carrying capacity (back pumps, power saws, hand tools, personal gear)

The weight of this bike, 180 pounds without load, is greater than most. Although this may be considered a disadvantage, it is offset by the desirable flotation, transmission ratio, and load-carrying capacity features of this equipment. All-around performance has been very good in comparison with other units. Some current uses offering the greatest potential are:

1. *Initial Attack.*—Up to now, ground crews with packs on their backs have been guided into lightning fires from float-equipped aircraft overhead. It may take several hours for a crew to walk to a remote fire, tying up a plane that could be urgently needed in other areas. The speed of the bike over abandoned hauling roads and skid trails puts a man on the fire earlier and in better working condition with more equipment and supplies.

2. *Line Supervision on Larger Fires.*—Good supervisory personnel are probably needed more with today's crews than ever before. Once lines are constructed, the bike could be helpful in making better use of sector or crew bosses for more rapid coverage of the line. In later mopup stages, a firefighter may be used to patrol a large amount of line from the bike, and report by radio on line conditions. Other uses, such as deliveries of supplies and small tools, are evident.

3. *Prevention.*—Inspections of occupied recreation areas, woods operations, and similar situations—which may be reached now only by walking—will be speeded up. Rangers will be able to keep up with visitors and others using trail bikes.

4. *Service.*—Servicing of remote lookout towers with supplies, communications, and maintenance gear can be done more efficiently.

5. *Other Uses.*—General administration activities on State lands not serviced by roads are facilitated by use of trail bikes. As with any machine, safety hazards are present and training must be provided to avoid personal injuries through careless use.

Operating cost figures are not yet available. A tankful of gas gives 8 hours of running time, and though the original cost of $800 appears high, time savings translated into dollars can be impressive. Large savings should result from the bike's ability to get that first man to the fire fast while there is still a chance of economical control. The possibilities for reducing damage and suppression costs are great.

Figure 1.—Bike with some firefighting tools for spring fires.

A FIELD TRIAL FOR REGULATING PRESCRIBED FIRE INTENSITIES

STEPHEN S. SACKETT, *Research Forester*
Southern Forest Fire Laboratory
Southeastern Forest Experiment Station

Certain firing techniques can be used to control the intensities of prescription burns. When lines of fire are set to permit spread with the wind, fire intensities are generally greater than those produced by lines of fire moving against the wind. Flank fires generally create intensities somewhere between those generated by head fires and backfires. Spot fires often generate the entire range of intensities—the leading edge behaving as a head fire, the sides as flank fires, and the rear as a backfire.

Multiple lines or spots of fire are often necessary when a large area has to be burned in a specified time. The lines or spots of fire have a "drawing" effect on each other where they converge, and their individual intensities become magnified in the junction zones. Since most fire damage occurs within these junction zones, the interval between fire sets is vital in regulating overall intensities.

PROCEDURE AND OBSERVATIONS

A workshop on prescribed burning was held recently on the Francis Marion National Forest, South Carolina. All burns took place in an open, mature stand of loblolly and longleaf pine averaging about 80 feet in height. Litter fuel consisted mainly of a 2- to 3-year accumulation of needles, and the vegetative undergrowth was composed of wiregrass (*Aristida stricta* Michx.), gallberry (*Ilex glabra* (L.) Gray), titi (*Cyrilla racemiflora* L.), and other minor shrub species.

Mild February weather prevailed: air temperature was 68°F. and the average relative humidity 34 percent; wind was light and from the southeast in the stand, with gusts up to 19 m.p.h. in the open. The spread index was calculated at 33, and the buildup index totaled 16. Three days had elapsed since the last rain (0.34 inch). Although the surface fuel was moderately dry, the soil was still damp.

Four 4-acre blocks were allotted for spot fires, and five for strip head fires. In order to evaluate the effect of distance between fire sets on behavior and intensities of the resulting fires, particularly in junction zones, the number of sets per block in the four spot fire blocks was varied as follows: 2, 4, 30, and 60 spots.

In the five strip head fire blocks, the strips were placed about a chain apart. All plots were burned the same day. Estimates of the resulting crown scorch served as gages of fire intensities. Scorch was classified as follows:

Class	Percent Crown Scorch
A	None
B	1-33
C	34-66
D	67-100

From observations of rate of spread, flame height, and vegetative fuel consumption, fire intensities appeared to increase directly with the number of ignition points, and were inversely related to the spacing between fire sets.

When examined for scorch 2 months after burning, the condition of the crowns supported preliminary observations. The strip head fire blocks had a greater percentage of Class C and D tree crowns than did any of the other treatment blocks. Scorch was negligible in those blocks that had been burned with 2 or 4 spots. In those with 30 and 60 spots, the percentage of scorch approached that in blocks burned with strip head fires (fig. 1). As the number of spots increased (spacing between decreased), the chances for convergence and greater intensities also increased.

Not all crown scorching results in damage to those species studied, but excessive amounts may be harmful. Scorching does, however, indicate the level of fire intensity. Because of the relatively large bole sizes and tree heights involved, observations made during this demonstration probably resulted in conservative interpretations. A younger stand would likely have suffered greater crown scorch and thus more potential damage.

CONCLUSIONS

The interval between fire sets appears to strongly influence the fire intensities created by prescription burning. Data from this demonstration indicate that, with many sets placed close together, it should be possible to produce a high-intensity burn. Conversely, a low-intensity fire should result from fewer sets and wider spacing.

In the South, most fire prescriptions in pine stands call for low-intensity fires that do not damage the crowns of crop trees. Sometimes, however, higher intensities are necessary: for instance, in clearcut areas where fire is used for slash disposal, or in mixed stands where hardwoods are undesirable and need to be controlled.

If further study shows that interpretations made in this demonstration are applicable for a normal range of fuel and weather conditions, another useful means will be available to regulate prescribed fire intensities.

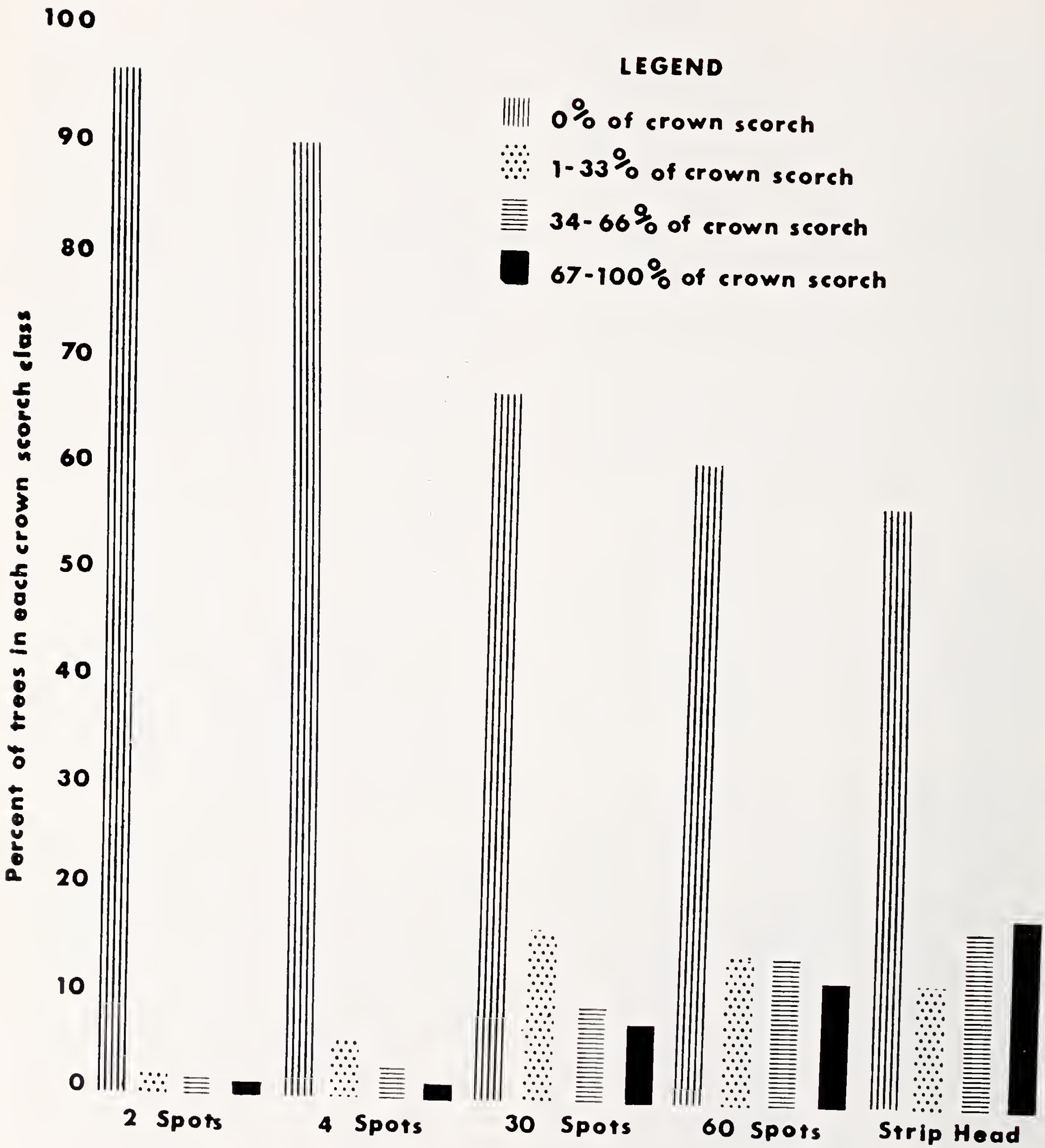

Figure 1. Crown scorch associated with a variety of firing techniques.

INFRARED MAPPING IMPROVES EFFICIENCY, CUTS COSTS OF FIRE SUPPRESSION

Robert A. Cook and Richard A. Chase[1]

"Intense smoke prevented effective scouting, either by ground or air. By use of infrared imagery in early stages, spot fires were picked up that were unknown to ground forces . . . perimeter imagery showed 720 chains of fireline to build rather than the 400 chains previously estimated. As a result, crews and equipment were reassigned to "beef-up" the north and south side . . . additional manpower and retardant drops were ordered. Use of infrared mapping saved 1 to 1½ sections of virgin timber . . . suppression costs were reduced at least $100,-000."

This report from a Northwest fire indicates the value of the Infrared Mapping Unit.[2] Using it, the Fire Boss can readily obtain current intelligence on fire behavior at night, or in spite of dense smoke cover, and direct his forces more efficiently.

The prototype mapping unit, resulting from 5 years of joint research by the Forest Service and the Office of Civil Defense, was released from the Fire Research Laboratory at Missoula as an operational tool in July, 1966, and has mapped many fires since.

Previously, Fire Bosses had to depend mainly upon daytime observations. While helicopters or reconnaissance planes greatly aid observers in gathering needed information quickly, they can be used only until it becomes too smoky, windy, or dark to fly. When these conditions prevail, it has been necessary to rely solely on ground scouting, which can be slow, and may provide sketchy and inaccurate information, since scouts must avoid the hazards of fire, smoke, and precipitous terrain in walking the fire perimeter. The data also may be obsolete when it reaches fire headquarters. By supplementing such methods with infrared mapping (fig. 1), Fire Bosses may now quickly acquire current information under almost all conditions.

OPERATION OF THE UNIT

The infrared mapping unit consists of a scanner, detector, printer, and associated electronic circuitry and controls; all units are mounted in a light twin-engine aircraft, with a crew consisting of pilot and operator.

As the aircraft flies over the fire area, infrared energy emissions from the ground are picked up by the detector and converted to an electrical signal, which is amplified and converted to a visual signal displayed on a cathode ray tube. This thermal picture is recorded on Polaroid film. The prints appear similar to aerial

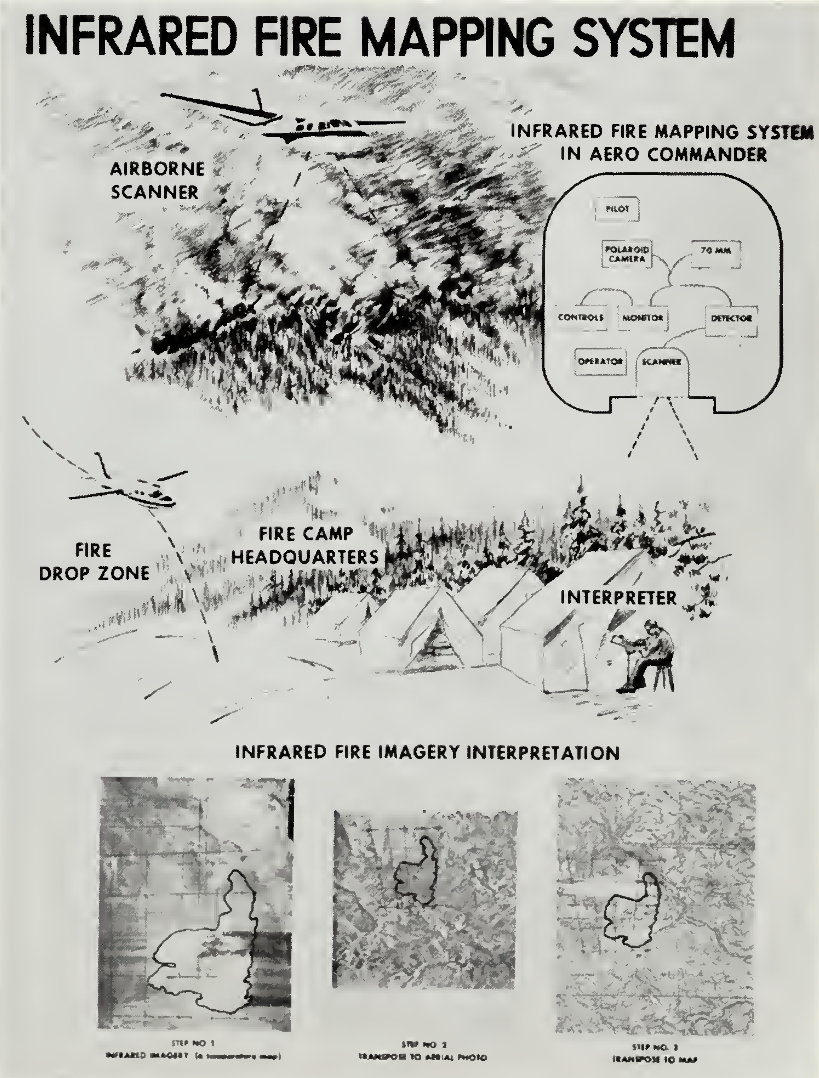

Figure 1.—Illustration of steps involved in infrared fire mapping.

[1] Respectively, Fire Control Technician, Western Zone Air Unit, Region 4, and Staff Specialist, Division of Fire Control, Washington, D.C.

[2] Bjornsen, Robert L. Infrared—a new approach to wildfire mapping. Fire Control Notes 26(3), pp. 3-4. 1965.

photos, with shades from black to white. The burning areas are white; brightness varies with fire intensity. Roads, buildings, open areas, timber types, and many topographic features are in various tones of gray because they emit infrared energy of lower signal strengths.

A mapping mission for the Forest Service begins with a request to the Regional dispatcher for the unit. This request, including details on fire location, fire headquarters, nearest airport, etc., is relayed to the crew. Usually the initial flight is made before the plane lands at the local airport. The imagery is delivered to the fire headquarters, where a trained interpreter transfers the fire perimeter and other data to aerial photos and maps. Subsequent mapping missions over the fire are coordinated by radio, and imagery prints may be dropped to the interpreter at the fire headquarters in a special plastic tube minutes after being made.

The best imagery is usually obtained at night, but satisfactory imagery can be made during daylight. Dawn and dusk are the poorest time for mapping. Though unaffected by smoke, imagery cannot be made through fog or cloud cover.

USED ON 21 FIRES IN 1966

The base of operations for the infrared mapper was established at Boise, Idaho, under supervision of the Division of Fire Control, Intermountain Region of the Forest Service, Ogden, Utah. The first operational use of the unit took place on July 29 on the Cottonwood Fire, Lewis and Clark National Forest, Montana. Before the summer was over, 21 fires in five States were mapped for the Forest Service, the Bureau of Land Management, and the California Department of Forestry.

An excellent example of the mapping unit's value was on the Indian Ridge Fire, Klamath National Forest. This fire was completely smoked-in for several days; helicopters and other reconnaissance planes were unable to operate. However, infrared imagery was obtained regularly at noon and midnight, furnishing vital information to fire personnel.

The largest fire mapped was the 20,000-acre Round Fire in August on the Mendocino National Forest, Calif. Here also, the smoke pall was extremely bad, and imagery was important in providing needed fire intelligence.

Redding, Calif., was the base of operations from Oct. 10 to Nov. 8. Some imagery was obtained for Civil Defense purposes, and an electronic technician was trained to operate the scanning equipment. Two California fires were mapped near Oroville during this period.

1967 OPERATIONS: 47 FIRES

During the busy 1967 fire season, the infrared plane flew nearly 400 hours serving Federal and State fire control agencies throughout the western United States, including Alaska, where it proved effective in detecting hot spots in tundra fires. A total of 47 different fires was mapped, many of them several times. Once during the August fire emergency in the Northwest, 14 fires were mapped in one night. The total area mapped each day varied, but reached nearly 100,000 acres several times. An example of the imagery obtained is shown in figure 2.

In addition to these fire missions, the unit participated in a Civil Defense exercise in Los Angeles and was used to obtain imagery of insect-killed timber in South Dakota for research purposes.

(Continued on page 16)

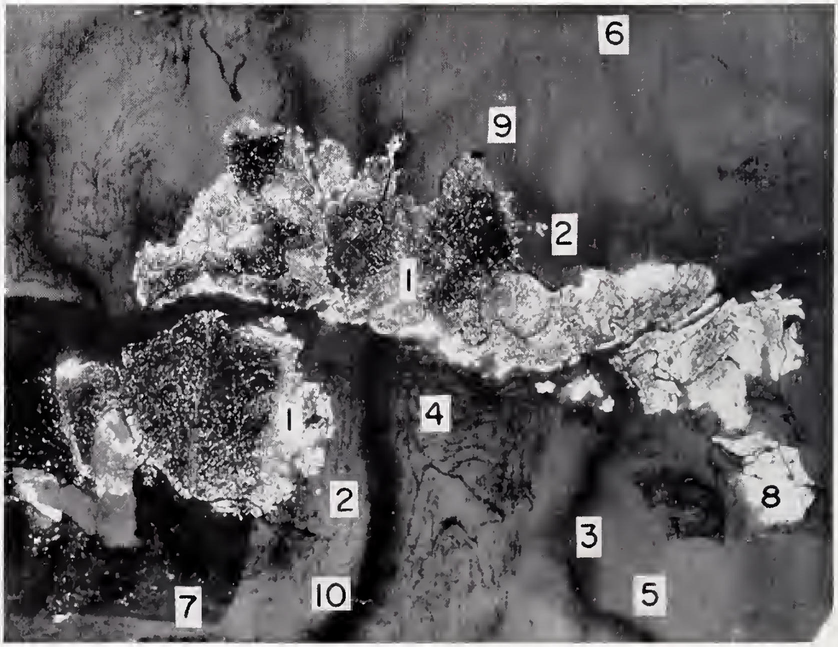

Figure 2.—Imagery—Shoepack Fire, St. Joe National Forest, Idaho, 9/26/67, at 2215, 5,000 feet over terrain. 1-burned area; 2-spot fires; 3-stream; 4-roads; 5-timber; 6-scan lines; 7-timber removed; 8-extreme heat; 9-fire camp; 10-flaw.

NATIONAL FIRE TRAINING CENTER

by EDWARD G. HEILMAN, *Forester*
Fire Control Training Field Support Unit
Marana, Arizona

As forest fire control becomes more complex, through the use of tools such as aircraft, fire retardant chemicals, electronic and other equipment, fire training needs become correspondingly more involved. Sink-or-swim training methods will no longer serve fire control goals.

Although for years the Forest Service has endeavored to improve fire training, having introduced such breakthroughs as fire simulators, programed instruction (including teaching machines), vastly improved films, and other means, it has recognized the need to keep fire training on a par with ever-expanding educational technology.

FACILITIES

In February 1967, the Forest Service's Division of Fire Control established a Field Support Unit at Marana Air Park, Marana, Ariz. (fig. 1). Because of the Service-wide scope of its activities, the training unit receives program direction from the Chief's Office, Division of Fire Control. Individual regions have access to the Marana unit through this division.

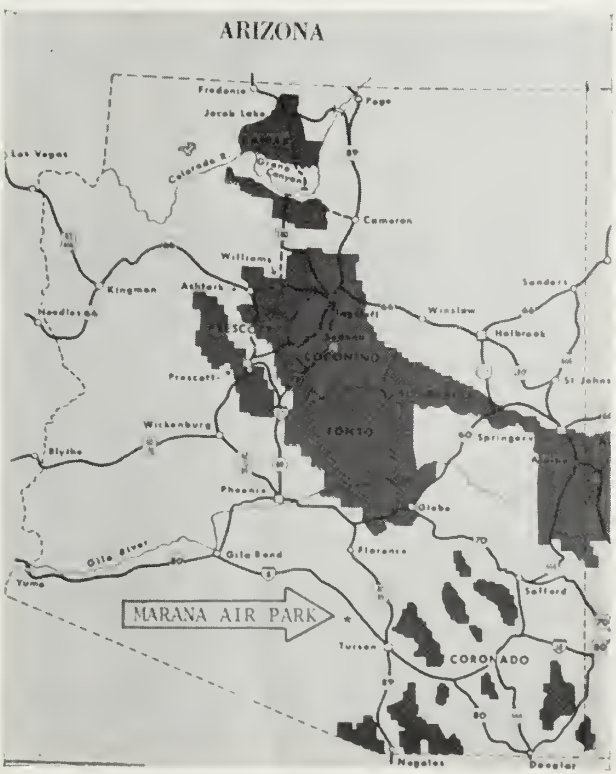

Figure 1.—Map showing location of Marana Air Park, site of the National Fire Training Unit.

Located 30 miles northwest of Tucson, the unit leases offices and classroom space to accommodate 100 trainees (fig. 2). Availability of housing and meals provides a live-in environment conducive to better learning.

The runways and other flight facilities at Marana offer on-the-spot opportunities for air operations training. The Air Park also serves as an air tanker base during the local Region's fire season from May through July.

MISSION

The Marana Unit serves fire control training needs by using modern learning techniques. Its main goal is to provide support to regional fire control training programs through:

Development and Use of Instructional Tools.

In contracting with instructional technologists, the Unit's position would be, "Here's what we want to teach," expecting the technologist to reply, "Here's how to teach it and the training aids needed." While most instructional tool development will probably be contracted, there will be in-house efforts involving regions and the Marana Unit. Examples of some instructional tools developed elsewhere are the programed texts: *Fundamentals of Fire Behavior, Ten Standard Firefighting Orders, Fire General Policy Review,* and various slide-tape programs.

Figure 2.—Classroom facilites at the Marana Fire Control Training Center.

Development of Service-wide Courses.

The unit will provide assistance in preparing and conducting such Service-wide training courses as Advanced Fire Behavior, Fire Generalship, Advanced Command Air Operations, Fire Prevention, Law Enforcement, and others. A large teaching staff is not envisioned. Instructors will be drawn from the field for temporary assignment as the course requires.

Distribution of Fire Training Aids.

During field trips and other contacts, the unit will evaluate locally developed fire training aids for Service-wide use.

Establishment of a Fire Training Library.

A technical fire control library has been established to provide field units, contractors, researchers, and trainees with a comprehensive reference library for assisting the fire training effort.

Assistance at Regional Schools.

With coordination by the Division of Fire Control, the unit will furnish on-site assistance at some regional schools, including qualification of fire simulator instructor teams. The Marana facilities are also available for regional courses. Training officers are encouraged to visit the unit.

Pilot-Testing New Training Methods.

The program includes evaluation of new "hardware" such as television systems (fig. 3), new teaching machines, and cartridge-loaded movie projectors; and it includes appraisal of "software" such as written or filmed programs. The unit maintains contact with the latest developments in both educational ideas and equipment.

The newest command system fire simulator has been installed at the Marana Center to furnish regular and advanced fire simulator training on both national and regional levels (fig. 4). It will also be used to develop and test new simulation procedures and equipment.

One example of this is a recently prepared air-oriented fire simulator exercise. In this exercise, observer-trainees are actively involved with the trainee fire team in decision-making through a parallel teaching system using Edex student-response equipment. The system uses programed audio-visual instruction and individual responder units where trainees indicate their answers to questions by pushing one of four buttons. By monitoring indicator dials, the instructor can immediately determine both individual and group responses. Using this information, he can furnish additional instruction as needed by the individual or group.

Figure 3.—Using television equipment to supplement classroom instruction.

Forest fire control today offers new challenges to the wildland manager. To meet them, improved fire training is necessary. The Marana Fire Control Center will help furnish this training to the field fireman.

Figure 4.—Umpire-Director booth, Marana command system simulator.

FOREST FIRE PREVENTION—THE VITAL ROLE OF COMMUNITY LEADERS

M. L. DOOLITTLE, *Research Forester*
Southern Forest Experiment Station

Key men in rural communities are often enlisted in forest fire prevention programs. They include elected officials, successful businessmen, farmers, and others influential in education, religion, economics, and government. A recent study by the Southern Forest Experiment Station's Forest Fire Prevention Research and Development Project at State College, Miss. indicates that the success of fire prevention programs may be related to the pattern of leadership in the community.

In the study, a rural community with a relatively low fire-occurrence rate was found to have general leaders who had the positions, records for action, and reputations associated with leadership. In a second community with a much higher fire-occurrence rate, there were many in high positions, but none whose influence was widespread, or who were regarded as leaders by most other residents.

STUDY COMMUNITIES

The two study communities were chosen for comparison because, while similar in such characteristics as land-ownership and use, and economic composition, their rates of forest fire occurrence differed sharply. The approximate boundaries of each were determined by asking residents to which community they belonged. As finally delineated, the study communities contained about 200 families each. The *High Rate* community was having over 10 times as many forest fires as the *Low Rate*. In both communities, incendiarism accounted for well over 50 percent of the fires. In *Low Rate*, fire occurrence had decreased sharply in the 10 years preceding the study. In *High Rate* it had been excessive for longer than local foresters could remember.

An investigation into the reasons for the contrast in occurrence rate disclosed that, in the *Low Rate* area, the forest protection agency had done nothing revolutionary to prevent fires, but, partially as a result of key-man contacts, residents spoke of fire prevention as a first-person activity. "We just showed people that fire setting wasn't the thing to do," said one prominent citizen. "We had regular forestry programs three or four times a year. We showed films to the school kids too, and that seemed to really help. Then we did a lot of just sitting and talking to people. We got a few people convinced, and the rest followed."

In contrast, people in the *High Rate* area discussed the Government and fire protection in the third person. For example, a successful dairyman said, "The Government has me surrounded on three sides. I don't know how they ever got hold of all this land, but a fellow can't buy any for love nor money. People around here don't get anything out of the Government land but a big headache. Why, it's got to where you can't even let a fire get out without the Government coming and trying to put you in the pen!"

LEADERSHIP PATTERNS

Leaders in the two communities were identified through their positions, community activities, and reputations. Positions normally associated with leadership included appointive and elective offices. Community activities included participation in public programs of importance to the whole community. Reputation, perhaps the most significant of the criteria of leadership considered, involved recognition as a leader by community residents. Names of those in important positions and those active in public programs were noted. People with a reputation for leadership were identified through interviews with community residents. In singling out leaders, emphasis was on area of influence.

In the *Low Rate* community, a few leaders with wide general influence emerged, regardless of identification criteria. Two of the four people most often named as leaders were elected officials, and a third had just completed a term in an elective office. One had demonstrated community action by encouraging voter turnout in a special county election to approve the building of a pine plywood mill. As an advocate of the building plans, he was almost certain to support forest protection programs. In this community, foresters had little difficulty in finding the right people to aid in a prevention program which proved very successful.

In the *High Rate* community, on the other hand, a large number of people emerged as leaders, but none was named often enough to be regarded as such in the whole community. One individual was influential among his immediate neighbors; another, the respected elder among a large, close-knit kin group; still another was recognized because of his vast land and cattle holdings. Such people were named as leaders by fellow residents more often than elected officials and others in positions normally associated with leadership, the effect being that the *High Rate* area had no general leadership at the community level.

Those regarded as key contacts by county forestry and agricultural officials attended State and regional agricultural conferences, participated in

the county forestry association, and represented the local political unit on the county soil and water conservation board. They were not, however, considered leaders by the other residents of the community. It is not surprising, therefore, that they had little influence over those who were causing forest fires, and prevention programs directed by them may even have been resented.

CONCLUSIONS

Where people of high position have little influence, and there are no general community leaders, local fire protection agencies face difficulty. When diffuse leadership is the only kind available (as is often true in the South), forest protection contactors must recognize and work with it, if he is ever to get effective fire prevention action.

The real question, of course, is, "How do you obtain assistance and support from such leaders once you find them?" To answer this question, scientists at State College, Miss., are making two studies. The first is of such things as leadership qualities, information sources, dissemination patterns, and areas and levels of influence. The other, prevention activities—ranging from personal contact to community organization and development—will be made under carefully controlled conditions. Scientists hope to determine how effective such activities are, both singly and in various combinations. Their findings certainly will not replace the effectiveness of personal contacts, but they may help those involved to increase their efficiency.

FLUORESCENT SIGNAL STREAMERS WORK WELL

Albert E. Boucher, *Smokejumper Foreman*

Redmond Air Center

Good communications is the key to smooth aerial operations. During busy fire periods, radios are at a premium, and ground personnel must communicate with support aircraft by visual signals. This is usually accomplished by laying 1-ft. by 8-ft. strips of colored material ("streamers") on the ground in signal patterns.

Those now in common use are made of crepe paper, cambric cloth, or thin plastic. Certain features of these materials can reduce their effectiveness. Coloring fades rapidly, wind makes it difficult to keep the streamers in position, and reflective qualities are inadequate under poor light conditions.

A vinyl-coated pennant cloth in bright fluorescent colors has proven very effective for this use. Available commercially at reasonable cost, it eliminates or greatly reduces the inadequacies of present products. Being colorfast, it will not fade. The material is stiff enough to remain flat in moderate winds, yet it is easy to roll or fold. The cloth is available in 38-inch-wide rolls and can be cut to size and shape with scissors.

The 40-man smokejumper unit at the Redmond Air Center, Oregon, was issued the new streamers on a trial basis for the 1967 fire season. They were used to signal aircraft for tools, food, water, etc. All comments were favorable. Pilots and observers reported being able to see and "read" the fluorescent streamers much more quickly and easily than the ordinary ones. Slight breezes didn't disturb them nor were they confused with small red cargo parachutes.

The Redmond Air Center smokejumpers have now adopted the new streamers and have also constructed message droppers using the fluorescent cloth.

The color used at the Air Center was called "Blaze Orange," but material is also available in "Arc Yellow," "Blue," "Signal Green," "Rocket Red," and "Saturn Yellow." The cost varies from 63 cents per yard for 500 yards or more, to 88 cents for less than 100 yards. The streamers tried by the Redmond smokejumpers were 9½ inches wide (to fully utilize the roll) by 12 feet long—equal to about one square yard. This material may be purchased from United Tent and Supply Co., 759-61 N. Spring St., Los Angeles, Calif. 90012.[1]

[1] Trade names and commercial products or enterprises are mentioned solely for information. No endorsement by U.S. Department of Agriculture is implied.

LARGE HELICOPTER USE IN FIRE SUPPRESSION

Division of Fire Control
Washington, D.C.

The value of helicopters for various fire control tasks has been established for 20 years. These versatile and efficient aircraft are now employed almost routinely on most large fires, and many smaller ones as well.

Most helicopter use has been with the light utility 2- or 3-place models with a load-carrying capacity of approximately 1,000 pounds. Large helicopters have been used only infrequently due to lack of availability. The high investment and operating costs of the larger models have discouraged commercial operators from purchasing them until opportunities for expanded use were more certain. Thus, they have generally been available to fire control agencies only in emergencies from military sources, necessarily limiting investigations into their potential for fire suppression work.

This situation is changing. In recent years, several western commercial helicopter operators have made large models available for fire use. Experience with these aircraft during the 1966 and 1967 fire seasons has clearly indicated that they offer an opportunity to significantly improve the efficiency of fire control forces in certain situations. Although the cost per hour for these larger models may run as much as 3 to 4 times that for lighter helicopters, this is more than offset by their larger capacities and improved performance (table 1).

Table 1.—General characteristics of some large helicopters now in use. Actual capacities will vary with local conditions and fuel weight.

Model	Passenger capacity	Payload (pounds)	Retardant Capacity (gals.)
Bell 204-B	8	4,130	3-400
Sikorsky S-58	13	5,040	3-400
Sikorsky S-61	(a)	7,400	7-900
Kaman H-43-A	(a)	2,400	2-250

(a) Not approved by U.S.F.S. for personnel transportation.

OPPORTUNITIES FOR USE

Evaluation of the performance of large helicopters during the past two fire seasons has pinpointed situations where they have definite advantages over other types of equipment. On personnel transport and cargo hauling missions, the performance characteristics and load capacities of these aircraft permit large volumes of men and equipment to be moved rapidly into a remote fire. With the Sikorsky S-58, for example, no more than three trips would be required to deliver a complete 25-man organized crew and its equipment. For a 5-mile ferry, the entire operation could be completed by one copter in approximately 20 minutes (fig. 1).

During the 1967 fire "bust" in Northern Idaho, three U.S. Army HUEY helicopters, the military version of the Bell 204-B, flying a total of 34 hours, moved 174 men and more than 12,000 pounds of equipment and supplies to four large fires in roadless areas. More than a dozen light helicopters would have been required to accomplish this task in the same time.

HELITANKER OPERATIONS

While fixed-wing airtankers offer advantages of high speed and large load capacity, necessary in many circumstances, the large helitanker has also proven an important tactical tool. With its great maneuverability, the helicopter can accurately pinpoint drops, and has achieved excellent results in close support of line workers. Also helicopter drops can often continue after fixed-wing operations have been curtailed by smoke and reduced visibility.

The relatively small load capacity of even the large helitankers, as compared to fixed-wing airtankers, is often offset by their ability to operate from water or retardant-mixing sources close to the fire. The "dip buckets" developed for these aircraft make it possible for them to load easily from

Figure 1.—The large capacity of the Sikorsky S-58 enables it to quickly move fire suppression forces to remote areas.

small ponds or portable retardant mixing plants in the fire vicinity without landing (fig. 2). Thus, little time is wasted in ferrying, and the helitankers can actually drop greater quantities than fixed-wing aircraft operating from distant bases.

In 3 days on the Airstrip Fire, Willamette National Forest, Oregon, one S-61 helitanker applied 147,000 gallons of water and 26,000 gallons of retardants. At the peak of operations it was delivering water at a rate of 9,000 gallons per hour! An additional 34,000 gallons of water and 10,000 gallons of retardant were dropped on this fire by a Bell 204-B and a Kaman helitanker (fig. 3).

LIMITATIONS

In contemplating use of large helicopters, their limitations must be considered and fire control personnel should consult closely with Air Officers. Much care must be taken to select suitable landing sites, since these larger craft have different requirements than the light helicopters familiar to most fire people. Also, the large models cannot hover at altitudes as high as those of some frequently-used small helicopters.

Figure 2.—A Bell 204-B helitanker loads its drop bucket with retardant mixed by a portable mixer near the firelines.

FUTURE POTENTIAL

Use to date confirms the large helicopter has a definite place in the fire suppression force. The high operating cost per hour is offset by the aircraft's ability to transport larger loads at faster speeds than lower-cost, smaller models; and in appropriate circumstances it can be much more efficient. Conversion from personnel transport to cargo carrier to helitanker can be rapidly effected, giving fire managers a versatile, increased-capacity piece of equipment.

Further improvements in the helicopters or related equipment, such as the lightweight helitanker buckets pioneered by the Pacific Northwest Region, will further increase their adaptability to many fire jobs. Because of present military requirements, the number of large helicopters available for purchase by commercial operators is limited. Some operators may still be reluctant to make the large investment required. It appears certain, however, that the availability of large helicopters for fire work is increasing. Fire control personnel should become acquainted with the potential benefits—and limitations—of large helicopters so they may consider their use in appropriate situations.

Figure 3.—The Kaman helitanker, with 250-gallon bucket.

NEW TRAILER-MOUNTED FIRE RETARDANT MIXER SUCCESSFULLY FIELD-TESTED

Franklin R. Ward, John D. Dell and William C. Wood[1]

A new trailer-mounted chemical fire retardant mixer (fig. 1) was successfully field-tested in the Pacific Northwest Region during the 1966 slash burning season. The test was done on seven high-lead or tractor-logged units on the Umpqua National Forest in Oregon. We used the unit to apply a fire retardant to perimeters of clearcut blocks for extra protection during broadcast burns; the retardant was also used to slow down rate of fire spread at critical points within blocks.

A 1½ ton stake-side truck towed the trailer and carried bags of retardant and water. On firelines inaccessible to trucks, a tractor did the pulling. Manipulation of the live-reel hose over slash was difficult and slow. The unit performed best on roadside application above slash units and on treating accessible draws and chimneys below the road level. The optimum crew size was three to five men, depending on amount of slash, topography, and distance hose had to be laid. When towed by a tractor or 4-wheel drive vehicle over firelines on moderately steep terrain, the unit handled satisfactorily.

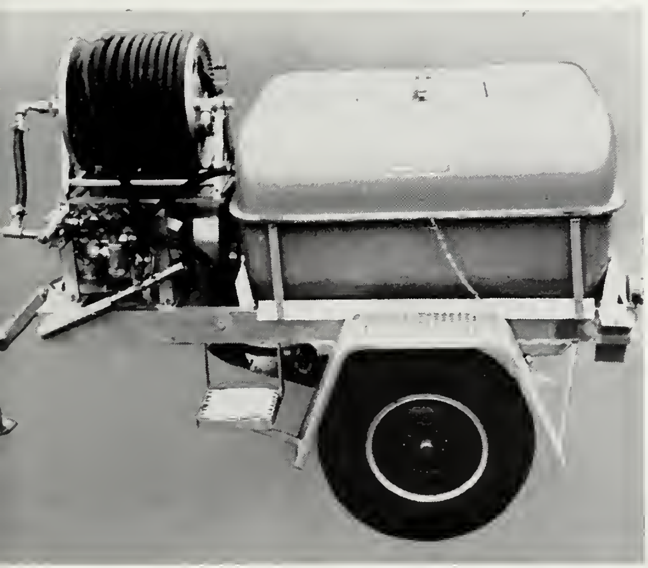

Figure 1.—The trailer-mounted chemical fire retardant mixer can hold 300 gallons.

The mixer unit consists of a 300-gallon fiberglas tank equipped with an impeller for mixing, a 12½ horsepower (at 3200 rpm) engine, a 250-foot capacity live reel, and a Seeger-Wanner Model A20F positive displacement piston pump rated by the manufacturer at 22 gpm, at 578 rpm, and up to 500 psi. These components are mounted on a heavy-duty, single-axle trailer. The equipment was assembled for the Forest Service by Mitchell, Lewis, and Staver Company[2] of Portland, Oregon, at a development cost of $2,127.

Engineers from the San Dimas Equipment Development Center made laboratory tests to determine if this unit could adequately mix the fire retardant Phos-Chek 259. They also tested Phos-Chek 202 and Gelgard M.[3]

The tests showed that the unit *could* mix Phos-Chek 259. It was the only retardant used in the field tests. Although no difficulty was experienced with the pump in the laboratory trials, even when pumping Phos-Chek 202 at 800 plus centipoise, both Phos-Chek 202 and Gelgard M were more difficult to mix than Phos-Chek 259. Changes have been made in the mixer to correct this.

The unit generally performed well in its first field trial, although a need for certain equipment modifications became evident. The live reel was not large enough to handle the amount of hose used, nor did it have a handle for rewind; a larger live reel with handle has been installed. The trailer did not have ample protection for belt and flywheel on the mixer shaft. A metal plate attached to the undercarriage corrected this problem. A maintenance kit and spare tire have been added and other minor repairs and modifications made. Further field use of the mixer is planned.

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[1] Ward and Dell are associated with the Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif.; Wood with the Pacific Northwest Region, U.S.F.S.

[2] Trade names and commercial products or enterprises are mentionel solely for information. No endorsement by the U.S. Department of Agriculture is implied.

[3] U.S. Forest Service, Mitchell retardant mixer. 1966 (Unpublished report on file at San Dimas Equipment Development Center, San Dimas, Calif.)

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Fire Hazard Management—*Continued from page 3*

Figure 2.—Same area as figure 1. Firing completed 2200—Sept. 20, 1967.

Figure 3.—Same area as figures 1 and 2. 2200—Sept. 21, 1967.

were checked on Nov. 13 with the following results:

50% laydown blocks . . .	58M seeds per acre
Spray block	50M seeds per acre
Natural area	132M seeds per acre

The traps were left in position for checking in the spring to determine later seed fall. The seed fall to date appears sufficient to establish a new, fully stocked stand.

Because the untreated areas cleaned up as well as the treated ones, we believe that *no treatment other than control lines is necessary to establish satisfactory fuel breaks in our high-hazard fuels.*

In merchantable stands, the salable material will be removed and the residual burned. The slash from the cut material will make ignition easier here. Standing stems will be killed by the fire and will furnish shade for the new seedlings.

Strategically located fuel breaks for controlling potential conflagrations are being given first priority as roads are developed through high-hazard units. They will be rehabilitated to develop full timber production potential as well as to fireproof them.

Infrared Mapping—*from p. 8*

Despite heavy use during the summer, the mapper functioned well. Minor electronic repairs were required only once, and the detector failed on one mission due to ice accumulation.

SUMMARY

Infrared imagery can reduce firefighting costs in many ways. In addition to accurately locating fire perimeters and spot fires, it reveals the relative intensity of the fire on the different sectors. Rate of fire spread can be accurately calculated from successive imagery made at timed intervals. Topographic and cultural features can be identified. All this information can assist the Fire Boss in establishing priorities for suppression on various parts of the fire and in selecting suitable control line locations. Manpower and equipment needs can be better estimated. In the mopup stage of the fire, new imagery pinpoints hot spots, permitting better scheduling and use of manpower.

Accurate interpretation of the imagery, and the subsequent transfer of information to aerial photographs and maps, is very important to its successful use. To facilitate broader application of infrared mapping, the Forest Service has trained 58 interpreters from Federal, State, and County protection agencies in Western States. More will be required.

FIRE CONTROL NOTES

U.S. DEPARTMENT OF AGRICULTURE/FOREST SERVICE/FALL 1968/VOL. 29, NO. 4

FIRE CONTROL NOTES

A quarterly periodical devoted to forest fire control

CONTENTS

COVER.—A B-26 air tanker attacks a small fire. Air tankers are an effective and efficient element of the fire control force when used on a planned, selective basis. See related story on page 6.

(NOTE—Use of trade names is for information purposes and does not imply endorsement by the U.S. Department of Agriculture.)

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COMBINATION HELITANKER-AIR TANKER ATTACK ON THE PINE CREEK FIRE

TROY KURTH, *Forest Research Technician*
Pacific Southwest Forest and Range Experiment Station[1]

A combined helitanker-air tanker attack can safely and effectively help control a forest fire if communication is constantly maintained between all aircraft and the ground and if operational procedures are followed. Excellent helicopter control can be maintained if all drop missions are directed by an Air Tanker Boss in a lead plane. These two points were demonstrated during the Pine Creek Fire of Aug. 9-11, 1967, on the Cleveland National Forest, Calif. The primary mission of the air tankers was to reduce fire intensity. Helitankers were assigned to specific targets that threatened to spot across or burn around retardant drops, to make the first attack on spot fires, and to support handline construction crews. An Air Tanker Boss in a T-34 lead plane directed all retardant drops.

AUGUST 9

The fire started in a remote section of the Pine Creek drainage during the hot, dry afternoon of Aug. 9, 1967. Flashing through the extremely dry brush and grass, it soon spread beyond the area where the initial-attack helijumpers could contain it. By dusk the fire had scorched more than 150 acres. And during the night it continued to burn actively. However, handcrews, fighting the rugged terrain as much as the fire, succeeded in confining the fire to the upper two-thirds of the west slope (fig. 1). Also, tractor operators managed to construct a 4-wheel-drive trail to the edge of the fire in the early morning hours.

AUGUST 10

At dawn, the Fire Boss faced a dangerous fire. More than one-half of the fire had only a scratch line around it. Using the three light helicopters at his disposal, the Fire Boss quickly ferried fresh crews into the critical sectors. Three ground tankers were able to reach the edge of the fire, and the helicopters rapidly laid 3,000 feet of hose to extend tanker operations on the fire.

At 0930 a flareup, beyond the reach of tankers, quickly exceeded the capacity of ground crews equipped with handtools. The three helicopters, now converted to helitankers, were able to delay the firespread. As the intensity of the fire increased, two fixed-wing air tankers were dispatched. They succeeded in reducing the rate of spread enough to enable ground crews, supported by helitankers, to control the flareup.

However, by 1030 the situation had become critical. The rapidly rising temperatures and rapidly falling humidities on the east exposure made the flashy brush and grass highly receptive to spot fires and flareups. The Fire Boss realized that low-volume helitanker drops would not be able to contain the flareups and spot fires.

With an Air Tanker Boss in a T-34 lead plane, additional air tankers were ordered.

Air-Attack Organization

The Fire Boss decided to set up an air-attack organization. He knew the hazards created by unorganized fixed-wing and helicopter operations over a fire area. The Air Attack Boss position was established. Then the Air Attack Boss established a pattern. The pattern utilized two frequencies:

1. Air net between all aircraft and the Air Attack Boss.
2. Forest net among the Air Attack Boss, fireline personnel, and the Helicopter Manager.

The Air Attack Boss and the Air Tanker Boss decided to combine all retardant aircraft, deploying helitankers in the same manner as air tankers. They established the following operational procedures:

1. All inbound air tankers would report to the Air Tanker Boss. When he was 3 minutes from the fire, the Air Tanker Boss would inform the Air Attack Boss.
2. Air tankers would maintain a minimum altitude of 1,500 feet over the fire until the Air Tanker Boss led them in on a target assigned by the Air Attack Boss.
3. The normal altitude at which helitankers would fly over the fire to the assigned target areas was 500 feet.
4. An air tanker would not be led in for a drop without the Air Tanker Boss clearing the drop with the Air Attack Boss.
5. The Helicopter Manager would not clear any helitanker for takeoff without first checking with the Air Attack Boss.
6. All operations would immediately cease if, for any raason, both the Air Attack Boss and the Air Tanker Boss did not know the exact position of any aircraft.

[1] Headquarters for the station is at Berkeley, Calif. The author is located at Riverside, Calif.

Information from the fireline personnel was transmitted to the Fire Boss and the Air Attack Boss on the forest net. The Air Attack Boss and the Air Tanker Boss determined the correct type of aircraft for deployment on every target.

Air-Attack Operation

In operation, all helitankers were refilling at the fire base heliport while an air tanker was being led in for a drop by the Air Tanker Boss. The helitankers were cleared for takeoff as soon as

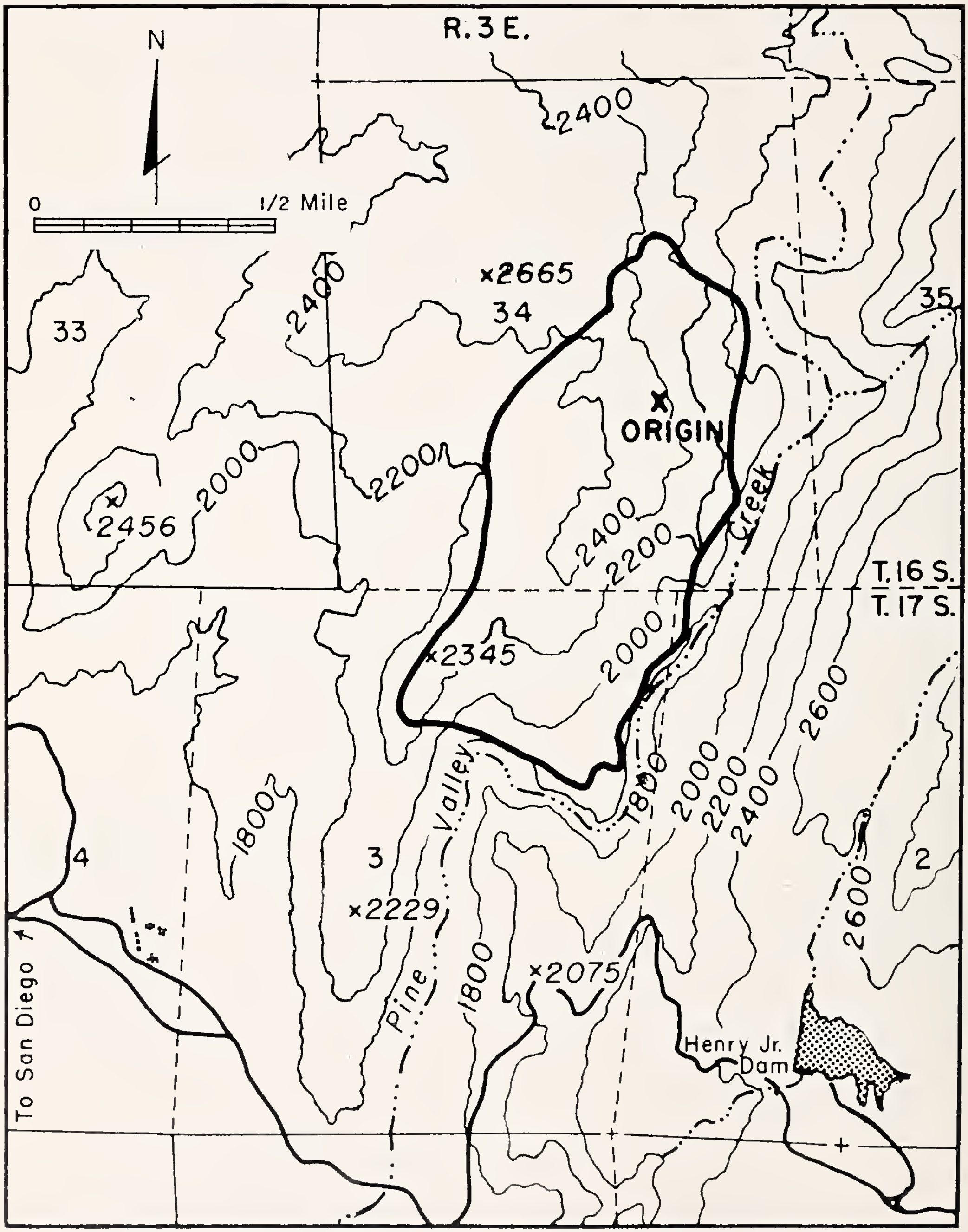

Figure 1.—Firefighters were confronted by rough terrain and were hampered by limited access in the Pine Creek Fire. The fire occurred on Aug. 9-11, 1967, on the Cleveland National Forest, Calif.

the air tanker completed its run. The Air Attack Boss, in turn, ordered the helitankers to the drop area, where the Air Tanker Boss directed them to specific targets. The helitankers were to knock down pockets of flame and spot fires that threatened to burn around or through the fixed-wing drops. This tactical maneuver almost eliminated the need for more than one air tanker drop at any point.

On several occasions, two air tankers would be led in, one behind the other, on a simultaneous run. One would drop immediately after the other so the most fire would be knocked down in the least time. The helitankers would follow up the air tanker drops to strengthen the lighter ends of the drop patterns and to assure an overlapping of the retardant line.

When air tankers were not over the fire, the helitankers assumed control. The Air Tanker Boss flew at an elevation that permitted him to view the entire situation. He would direct the helitankers to targets within their individual or combined capacity. This plan assured the Air Attack Boss that priority targets were being attacked.

During the brief lulls in air activity, the Air Attack Boss and the Air Tanker Boss would establish target priorities and would decide on the combinations of integrated attacks to be used when the loaded air tankers reported back to them. Several times during the day, helitankers were ordered to fast-breaking spot fires and flareups at the same time as ground forces were being notified of their existence.

Summary

By 1630 the three helitankers had dropped more than 18,000 gallons of retardant, had ferried 280 men to and from the fireline, and had delivered 7,900 pounds of urgently needed supplies to the ground crews. Four pilots were assigned to this operation, as the helicopters were in almost continuous use from 0600 to 1630. The average round trip required about 5 minutes; however, some of the flights to and from the north end of the fire were completed in less than 1 minute. Personnel transport was done as efficiently as possible and, under most conditions, two men were carried in and two men were carried out during one round trip.

The one B-17 and five TBM air tankers dropped 37,700 gallons of retardant on the fire. The last TBM tanker drop, at 1635, extinguished the last visible flames on the fire. By sundown, the fire was contained within an adequate fireline at 310 acres. The fire was announced as under control at 0900, Aug. 11, 1967.

TRAINING PAYS OFF

John E. Boren, *Investigator*
Kisatchie National Forest

One year in jail—that was a recent sentence imposed by a Louisiana State judge on a man who intentionally set three fires on the Kisatchie National Forest. This judgment resulted from vigilance on the part of a Forest Service employee.

For the past 2 years the Kisatchie National Forest has been stressing the need for Forest Service personnel to be observant. At law enforcement training sessions, the Forest Investigator has urged foresters not just to look, but to "see", what evidence may or may not be present at the scenes of fires or other possible criminal violations occurring on the National Forest.

Early one dry morning, a Catahoula Ranger District fire prevention technician answered the office phone. A voice said, "There's a ground fire at the Stuart Recreation Area." The technician notified a fire suppression crew, then left in his pickup. Arriving at the area, he saw a man trying to stamp out a fire. Then two more fires—very small. He also noticed there was no one else around. A moment's discussion revealed the helpful man who called about the fire had then come back to help put it out. (The nearest house was over a mile away. Two of the fires were only as big as a hat when the technician arrived.)

This man muttered a name and that he was from Olla, a small town 50 or 60 miles away. He then got in an old model, light-colored car and drove away. The technician did not see the license number, but did observe a name written on the driver's door.

This information was relayed to the Kisatchie Investigator, who launched an immediate investigation. Local inquiry revealed no likely suspects who could have set the fires. But a check with other local law enforcement officers disclosed that several families with last names similar to that of the "helpful" man lived in the vicinity. The Deputy Sheriff at Olla advised that he knew of two men by that name, and that one of them *did* own an old model car with his name writ-

(Continued on page 16)

AIR TANKER USE: A 5-YEAR APPRAISAL

Division of Fire Control
Washington, D.C.

More than 45 million gallons of water and fire-retarding chemical solutions has been dropped on forest fires by the Forest Service since its air tanker program was started about 12 years ago. A comparison of the National Forest protection area burned during this period with that of the previous 10 years shows a reduction of more than 20 percent. Certainly intensified prevention efforts and many improvements in equipment and techniques have contributed to this reduction. But it generally has been felt that air tankers have played an important role in effecting it.

The Study

In order to better measure their value, in 1962 the Forest Service initiated an administrative study to appraise the effectiveness of air tanker drops on going fires. During the 5-year period from 1963 through 1967, a sample consisting of 922 individual drops was evaluated.[1] Data studied for each drop included information on the fire (size, fuels, topography, spread characteristics, etc.), weather, tactical objective of the drop, and how much it helped ground forces bring about control. If rated less than a "definite help," the reason for the drop's ineffectiveness was also noted.

The fires and individual drops represented in this study were selected by chance rather than by a systematic sampling method. Evaluation was done by selected fire control personnel, and at times they were needed for fire suppression duties at the sacrifice of making the evaluations. However, the data gathered reflects a variety of fire and drop conditions, and is, therefore, felt to be representative.

Results

Overall, the benefits of the air tanker drops sampled were impressive. Seventy-nine percent were reported to have been of "probable" or "definite" help to ground forces in controlling fires (table 1). Seventy-one percent were "on target," and 15 percent were reported as "partial misses." The remainder (14 percent) were "complete misses," caused mainly by such factors as height or speed of the aircraft, poor visibility, difficult target, and mechanical failures. Misses due to mechanical problems noticeably declined over the 5-year period, reflecting the continuing improvements made in tank gates and related equipment.

TABLE 1.—*Air Tanker Drops Evaluated and Their Reported Effectiveness*

Evaluation of Effectiveness	Number of Drops	Percent of Total
Definite help	576	62
Probable help	155	17
Doubtful help	73	8
No help	118	13
Total	922	100

Complete misses accounted for two-thirds of those drops evaluated as being of doubtful help or no help. Another 12 percent of the drops rated ineffective was judged by evaluators to have been unnecessary, i.e., even though the drops hit the target, ground forces could probably have readily controlled the fires without them. The remainder of the "ineffective" drops was so rated because the fire subsequently *burned through, spotted across,* or *flanked* the retardant line.

Evaluation

Results of this study indicate that air tanker drops have the greatest chance of being a definite help in control of smaller fires (fig. 1). Better than two out of three drops on Class B and C fires (0.26-99.9 acres in size) were rated as being a "definite help." On fires 100 acres and larger, only two of five were so rated. The relatively low-rated effectiveness of drops on Class A fires (0.25 acre or less) may be explained by the fact that their small size makes them a difficult target. Being small, they are also likely at times to have been controllable by ground forces alone, and thus the air drop was rated ineffective because it was unnecessary.

Of the drops evaluated, the highest percentage rated as a definite help were those made on the head of the fire (table 2). Where character of the fire is a concern, air tanker use is generally of least value on fires with a slow rate-of-spread (fig. 2). More than one-third of the drops studied were made on "smoldering" and "creeping" fires, with only 46 percent rated of definite assistance, undoubtedly because they were often unnecessary for control.

[1] Drops by helitankers made up only 3 percent of the sample studied; therefore, results reported are generally most applicable to fixed-wing tankers.

Table 2.—*Retardant Drops by Target Area*

Fire Target	Total Drops, percent	Definite Help Drops, percent
Head	51	73
Flank	24	50
Rear	3	38
Spot fire	22	52

While these data might imply that retardants are most effective when used on the *head* of *fast-moving* fires, some caution is wise. Both logic and experience indicate that such drops will be futile in situations where the fire will burn or spot across, or flank the retardant line before adequate followup action can be taken.

In general, there was no marked variation in reported effectiveness of the drops by type of fuel in which the fire burned. The percentage of air tanker drops reported to be of definite help ranged from 56 to 66 for grass, brush, litter, and overstory fuels. In slash fuels, 76 percent were so evaluated.

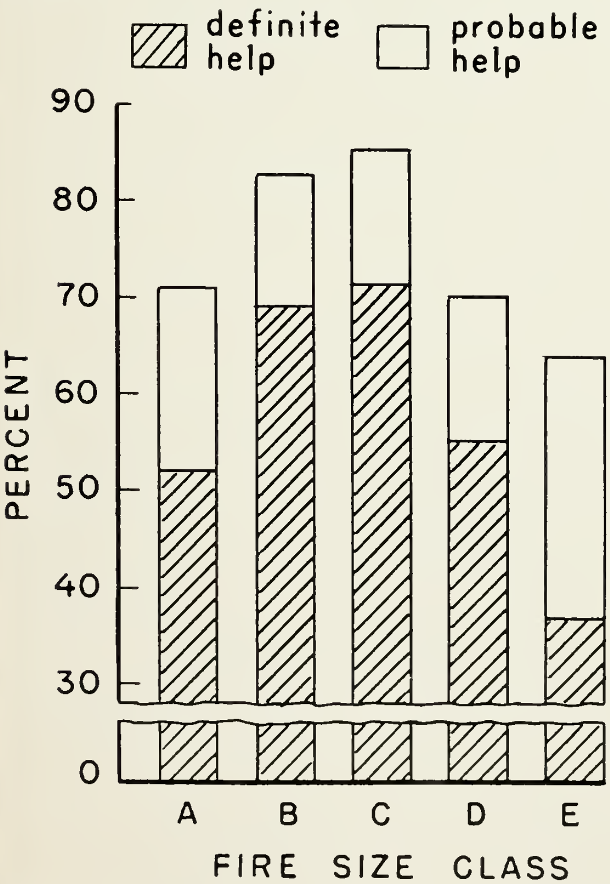

Figure 1.—Percent of drops rated of definite or probable help, by fire size class.

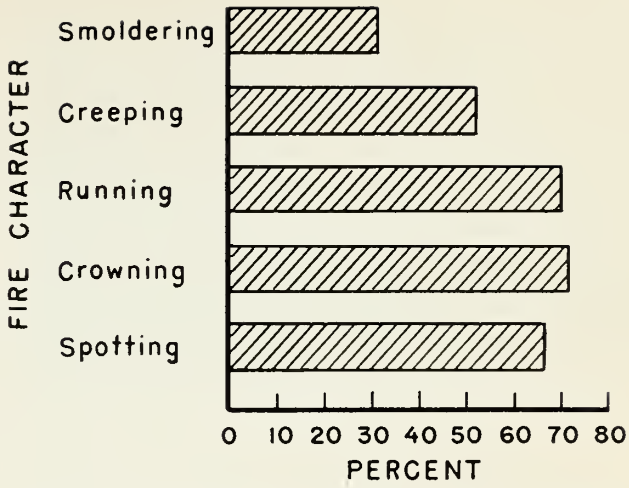

Figure 2.—Percent of drops rated a definite help, by character of fire at time of drop.

Slope gradient of up to 70 percent does not appear to be significant to the effectiveness of air tanker drops. The sample did not include enough drops on steeper slopes to be meaningful, but there is an indication that the chance of such a drop being effective decreases, particularly on those slopes with greater than 80 percent gradient.

No correlation was noted between percentage of drops rated a "definite help" and windspeed up to 14 m.p.h. Above that rate, effectiveness decreased with increasing windspeed. While the sample included relatively few drops made with windspeeds greater than 25 m.p.h., only about one-third of those evaluated were believed to have materially assisted ground forces.

Reports indicated the highest percentage of "definite-help" drops occurred when the tactical objective of the drop was line building in direct attack (table 3).

Table 3.—*Retardant Drops by Tactical Objective*

Tactical Objective	Total Drops, percent	Definite Help Drops, percent
Line building, direct attack	23	79
Line building, indirect attack	4	69
Delaying	29	62
Cooling to hold line	21	58
Cooling spot fire	15	51
Reinforcing weak line	8	37

Use of air tankers generally was less effective during periods of high fire danger. With burning indexes of 0-50, 63 percent of the drops were reported to be of definite help; above that index level the average decreased to 54 percent.

(Continued on page 13)

CHAPARRAL CONVERSION PROVIDES MULTIPLE BENEFITS ON THE TONTO NATIONAL FOREST[1]

J. J. BALDWIN, *Forester*
Tonto National Forest

Chaparral vegetative types on the Tonto National Forest are at 3,000 to 5,000 feet in elevation. At this elevation range, annual precipitation is 15 to 25 inches. Here temperatures during the summer are more than 100° F. during the day and relative humidity is often less than 10 percent. In heavy stands the volumes of this chaparral fuel range from 30 to 50 tons per acre.

The grazing capacity of chaparral is low for both wildlife and livestock because of the impenetrable cover and little herbaceous growth. It is difficult to manage cattle in the dense brush. Local livestock operators often must rely on cattle traps around the few watering areas to capture their animals for branding or marketing.

Watersheds in dense chaparral produce little water because of both high plant transpiration and high evaporation loss when rainfall is intercepted by dense vegetative cover. Soil erosion and offsite soil movement are common under the brush cover.

Wildfires in this chaparral type are frequent, and they often burn with explosive intensity. The cost of suppressing these fires may easily exceed $30 per acre. As a result, a prescribed burning program has been underway since 1961.

Burning plans included coordination of all land uses. The objective of this project was to burn the dense chaparral and to convert the area to open Savannah-type grassland, retaining islands of chaparral for wildlife cover. Riparian vegetative types were also to be protected because of their value for wildlife and for use by recreationists.

Figure 1.—Typical cover conditions in Brushy Basin prior to prescribed burning treatment.

Experimental burns were conducted in 1961 and 1962. In accordance with Forest Service fuel hazard reduction policy, it was decided to use fire as a management tool in large chaparral areas.

The Brushy Basin Project

About 5,000 acres in Brushy Basin, 50 miles northeast of Phoenix, Ariz., in the Tonto National Forest, were selected for the first major prescribed fire treatment of chaparral in the Southwestern Region (Arizona and New Mexico) (fig. 1).

Plans were made to control-burn small segments; all burning of the Brushy Basin area was to be completed in 3 years. A study of fire weather was initiated prior to burning to establish criteria for safe burning. Late September and all of October were chosen because the most favorable burning weather occurred then. Individual periods lasted from 1 to 8 days. In later years, application of new, special safety precautions extended this period of safe burning.

Early in 1963, fuel breaks, designed to be permanent, were selected and constructed in the most strategic locations. Where possible, these fuelbreaks were built with bulldozers to widths varying from 75 to more than 200 feet. When topography prevented the use of bulldozers, lines were built by hand and widened just prior to the major burn by burning out on the side toward the area of the controlled burn.

Experiments were also started to determine if the application of plant desiccant chemicals (2-4-D and 2-4-5-T mixed) would materially aid burning. These experiments are continuing.

All new employees of the Tonto National Forest were introduced to prescribed burning as a training measure during their first year on the Forest. Because of this training we believe these men are now permanently better prepared to cope with fire situations. Burning crews were assembled when weather conditions met established criteria. Except for key people, these crews were not experienced in fire control or fire behavior.

Initial burning was completed in 1965, and a grass cover was established by 1967. It is now apparent even to the average viewer that conversion of chaparral to grass is practical.

[1] Adapted from a paper presented at the Tall Timbers Fire Ecol. Conf., Tallahassee, Fla., March 1968.

The public has been kept well informed since the early stages of the program; this effort was made to gain and then increase understanding and acceptance of the burning project.

Firing Methods

Burning procedures changed as improved commercial ignition devices became available. The drip type and pressurized diesel torches were replaced by grenades and electrically detonated preplaced "squibs." Our main tools now include napalm grenades, grenade launchers, Very pistols, fusees, handheld butane torches, large butane weed burners, and electrically detonated grenades. Electrically fired devices are becoming more popular because they provide greater flexibility in ignition and increase safety for the firemen.

To obtain proper consumption of chaparral fuels, a crown fire is required. Thus, burning conditions must be high if the desired results are to be gained. Wildlife islands and streamside vegetation are saved by skillful burning ahead of the main burn. This is usually done during the afternoon and night before the main burn by firing away from and through these desirable areas.

Firing for the main burn is begun from the tops of ridges using a backing fire. This widens the control line. Firing then progresses downhill along the sides of the areas to be burned. Once the margins have burned to a sufficient width, strip head-firing is started. The entire bottom of the slope is ignited for an uphill sweep. All steps must be in sequence and properly timed. Crews must be in constant communication.

A favorable 5-day weather forecast is desirable prior to any burns which will last for more than 1 day. During all burns, weather must be observed continuously and reported, and forecasts must be interpreted so the fireman may be kept fully informed on the possible effects of weather. Decisions to proceed or to halt the burn depend on these forecasts.

Revegetation Successful

When the burn is completed, the area is ready for seeding to grass (fig. 2). Seeding has been successful both immediately following the burn in the fall and in the next July just prior to summer rains, but the latter time appears to be better. Regardless of seeding dates, germination does not occur until after August rains. Livestock grazing must be deferred during grass establishment, and the area must be properly managed following establishment of the grass.

Figure 2.—A view of the Brushy Basin area immediately after prescribed burning.

Within 18 months after the burn is completed, the burned area must be sprayed with herbicides to prevent resprouting of the brush. Spraying is repeated annually for at least 3 years to obtain a successful sprout-kill and to maintain the open Savannah-like type. All but 3 of some 20 species of brush involved are prolific sprouters. Three other species readily produce new plants from the seed left on the ground after burning (fig. 3).

Multiple-Use Benefits

Studies on the Brushy Basin and adjacent areas indicate that water production increases about 1.5 inches per acre. Good-quality water is now permanently flowing in the area. During years of heavier precipitation, water yields increase from 1.5 inches per acre per year to as much as 6 inches per acre per year.

After observing the results of burning and subsequent treatment from 1961 through 1963, the Salt River Valley Water Users Association is now contributing financial support to chaparral con-

Figure 3.—Established grass cover on treated area. Application of herbicides will check the brush regrowth.

version projects using prescribed fire as the initial treatment. The association believes the benefits will be sufficient to meet the cost.

Prior to treatment, annual grazing use in Brushy Basin was approximately 20 head of wild cattle. Beginning in 1967, 200 head of cattle was placed on the area under a rotation system of range management. Based on observations, it is clear that more cattle could be grazed if the forage being produced is to be fully used. It is too early to determine exactly how much grazing capacity will have been increased.

White-tailed and mule deer also use the area. The burn-and-spray treatment has improved the deer habitat, but further study will be needed to fully evaluate how much the total wildlife habitat has improved. Increases in the quail population after treatment have been noted; also, this spring's songbird population increased notably.

Conclusions

Chaparral conversion on the Tonto has proven to be an economic success. With increased water production and beef production, and reduced fire suppression costs, \$3 is being realized for each \$1 spent. This analysis does not place an economic value on increased wildlife use, or on use by recreationists for camping, picnicking, and general outdoor enjoyment. Another intangible benefit is the training we are able to give all personnel who have worked on the Tonto since the conversion program became a reality.

FIRE PROTECTION ON THE OUACHITA

Louis L. Davis, *Fire Staff Officer,*
and Robert C. Roberds, *Forest Dispatcher*
Ouachita National Forest

The Ouachita National Forest, established by Presidential Proclamation in 1907 as part of the Arkansas National Forest, has a gross area of 2.5 million acres with 1.5 million acres of National Forest land. It is located in the Ouachita Mountains of Arkansas and Oklahoma, a system of long, narrow ridges, lying to the east and west (fig. 1). The area is subject to periodic prolonged drought, occurring at 8- to 10-year intervals.

The area's original fire control organization, composed of guards and patrolmen scattered thinly over the Forest at strategic mountaintops, patrolled assigned areas daily throughout the fire seasons. Communication was by word of mouth and travel by horseback or on foot. Tall trees served as lookout towers. Fires were attacked as found. The main suppression tool was often a pine top.

Figure 1.—A typical view of the Ouachita Mountains.

By 1925, the situation had greatly improved. A telephone net spread over the Forest. Roads and trails were being developed, lookout towers and guard dwellings were built, and motor vehicles were in use. There was a large rural population, with communities in every valley. Trained warden crews were the backbone of the fire control organization in these valley communities. Each warden was on the Forest telephone net, had a tool and ration cache, and transportation.

During the depression years of the 1930's, the rural people began migrating from the area. Row crop farming did not provide necessary subsistence, and there was little or no market for timber. The warden system began to break up. The impact was not extensively felt at the time since the Civilian Conservation Corps took over the fire suppression job.

World War II stripped the Forest of needed manpower with military service demands, industrial labor requirements, and the closing of the CCC. After World War II, improved equipment, such as radio communications networks and the mountain fire plow, absorbed some of the responsibility. Intensive timber stand improvement under the Knutson-Vandenberg Act helped to beef up the area's manpower resources. The Ranger District then served as the fire control unit. Initial attack was made by regular Forest Service personnel with backup by volunteers recruited from local towns and communities. But in bad years, the manpower situation was critical.

A New System

By 1960, it was apparent that a reorganization was necessary if the Forest was to continue to meet its responsibility. Accepting the facts that large numbers of firefighters would not be available on short notice and that the Forest had small crews of skilled firemen on each District, the problem was how to make the most of available resources.

After much research and study, the following steps were taken:

—Supplemental air detection was activated in early 1963; most of the towers were abandoned, releasing the lookouts for ground service. This system consists of two contract aircraft with pilot and obesrver flying planned routes (fig. 2).

—The Master Plan was revised, dividing the Forest into two fire control units of six Ranger Districts each. The dispatching organization consists of a forest dispatcher and two zone dispatchers. The action plan authorizes zone and forest dispatchers to dispatch the nearest crew and equipment to the fire regardless of district boundaries, without the time lost in having to request such help from the Ranger involved. It also provides specifically for shifts in responsibility from zone to forest dispatcher, or reverse, as conditions change.

—An air tanker base was established at Fort Smith, Ark., within 30 minutes flying time of most of the Forest. Multiengine tankers, carrying from 1,200 to 2,400 gallons of retardant, are used.

—The Weather Bureau began daily fire weather forecasting at Fort Smith in early 1964. The forecaster is in direct radio communication and usually gives revisions as soon as changes become apparent. He also provides spot forecasts for going fires and for prescribed burning.

—The communication plan was revised to provide for a separate frequency for each zone instead of a single frequency handling heavy traffic. This system, with all new V.H.F. equipment, gives ground-to-ground direct contact, zonewide, through repeaters. The dispatchers have both frequencies.

These changes required much training and practice. Weaknesses that appeared were ironed out by plan revision and more training.

The 1967-68 fire season showed the new organization was functioning as planned.

Figure 2.—The Fire Detection Team, Ouachita National Forest.

Air-Ground Detection

The air-ground detection system meets detection time standards, eliminates false alarms, and provides prompt scouting of going fires. A side benefit is the aircraft's preventive effect.

Dispatchers know the location of every crew and piece of equipment in their respective zones each day. Dispatching is prompt and attack fast and aggressive. During a multiple fire situation in 1966, one blowup fire was hit by top firefighters and equipment from five Ranger Districts. It was controlled at 900 acres in 12 hours—10 hours before the next burning period.

In 1963, the air tankers, directed by ground forces with no experience in their use, performed extremely well. At least five fires were prevented from becoming project fires, saving hundreds of thousands of dollars in suppression costs and damages. The tankers have become even more effective as people become more experienced in their capabilities and limitations.

Rangers express a sense of security, knowing that skilled help is available that an aircraft is only minutes away, and that the air tankers are warmed up and ready to go. Direct radio contact with their people and other Rangers has eliminated the need to relay messages.

Method changes are difficult and sometimes painful, but the Ouachita will continue to change as needs indicate. With the intensive mechanization of agriculture and the timber industry, firefighting manpower will continue to be scarce. Thus, adjustments must be made to take advantage of new developments in fire control.

MARKING TEMPORARY HELISPOTS AND DROP SPOTS ON PROJECT FIRES

REID JACKSON, *Fire Staff Officer*
Boise National Forest

Many project fires involve extensive use of both helicopter and paracargo aircraft. It is not unusual for six or eight helicopters to be working on a single major fire at any one time. Also, it is not unusual to have four or five spike fire camps, serviced primarily by helicopter or/and paracargo, for one fire.

Current Deficiencies

To help minimize flight time and to improve the efficiency of helicopter and paracargo operations on project fires, an effective system of marking the numerous helispots and paracargo drop spots is needed. The present marking method varies from little or no marking (only written or verbal description to pilots) to marking with colored streamers. The streamers are frequently blown out of shape and are difficult to locate and identify. Helicopter pilots use limited, expensive flying time locating helispots used to deliver men and supplies. Paracargo pilots, besides using expensive flying time locating drop spots, occasionally are unable to identify the drop spot and have mistakenly dropped cargo in the wrong area. When such mistakes are made, fire managers cannot provide vital supplies for their firefighters at the proper time and place.

Improved Marking System

A marking system that has minimized the flight time and prevented mistaken drops is now being used on the Boise and Payette National Forests. The markers are constructed of Herculite, a plastic-impregnated nylon cloth obtainable in various weights and colors. Large, high-visibility standard marker symbols are sewn onto a sheet of this material. The colors of the material and markers contrast. The Boise uses red on yellow for helispot markers and red on white for drop spot markers. The markers are square and measure 100 inches on each side; therefore, it is easy to spot them and to correctly identify them by number (fig. 1).

The markers are assembled in a kit. The kit consists of the marker, eight 12-inch metal tent pegs, nylon cord for tiedowns, and a small canvas carrying bag. The kits are manufactured by smokejumpers during the winter. The helispot markers and the canvas carrying bags for the Boise are numbered consecutively, from 1 to 16. Fewer drop spot markers are needed; the Boise keeps 8 in its cache, and these, too, are numbered consecutively, from 1 to 8.

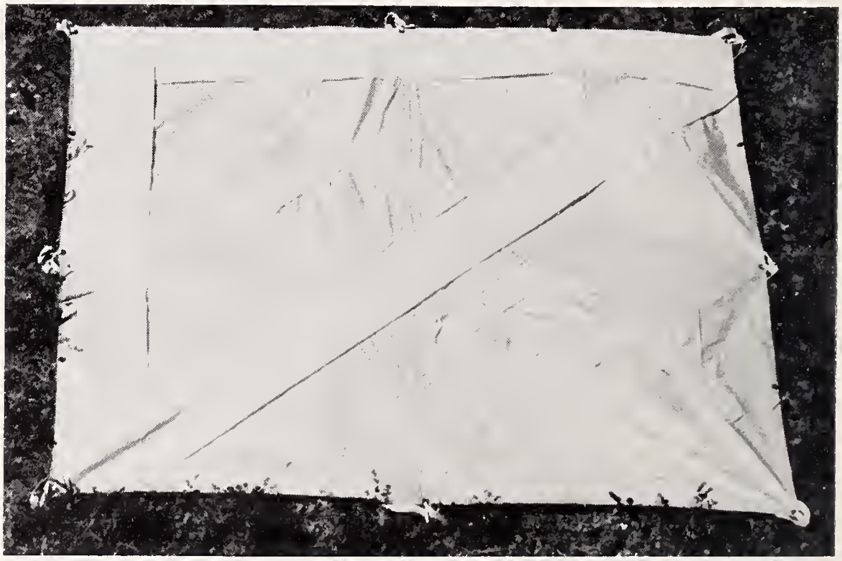

Figure 1—Temporary helispot marker (top) and drop spot marker (bottom).

Advantages of New System

By assigning a numbered marker to each helispot and drop spot, dispatch of pilots is simplified, control of two phases of air operations is improved, and flying costs are reduced (fig. 2). The savings could be several hundred dollars on a single project fire where numerous helicopters or/and cargo aircraft are involved.

The Herculite is strong and washable; thus, the markers can be placed directly over the touchdown pads and help reduce the dust problem associated with many emergency helispots. Markers must be securely tied down, using tent pegs and nylon cord provided with the kits. This will eliminate the damage resulting from blade down-wash blowing the markers into the rotor blades. Tying the markers also insures that symbols and numbers will be visible at all times.

The initial investment in the markers is somewhat high—$34.50 each—due primarily to the high cost of the Herculite. However, the markers can be used repeatedly; thus, the price is a fairly minor consideration.

Figure 2.—Markers are easily located and identified from the air.

The savings in reduced flight time would quickly offset the cost of the markers.

Additional Information

Formal specifications have not yet been developed for the markers, but units interested in obtaining kits can now order them from the Boise or Payette at the following addresses:

Forest Supervisor
Boise National Forest
413 Idaho Street
Boise, Idaho 83702

Forest Supervisor
Payette National Forest
Forest Service Building
McCall, Idaho 83638

Air Tanker Use—*Continued from page 7*

Conclusions

Although this study is based on some necessarily subjective judgments by individual evaluators, it shows that air tankers have provided substantial assistance to ground forces. But it also points up the necessity for using them on a selective, planned basis for the utmost efficiency since they are a relatively expensive fire suppression element.

Air tankers are, in general, most effective in the early stages of a fire. On larger fires, the chances of effectively aiding ground forces with retardant drops tend to decrease significantly unless very sound judgment is used in selecting appropriate targets. In all cases, the decision to use air tankers must be based on careful analysis of the particular situation. Fuels, weather, fire behavior, topography, followup action, and the difficulty the air tanker may have in hitting the target are all factors that must be considered in deciding *first,* whether the retardant drop is actually needed for control, and *second,* what the probability is that it will, in fact, accomplish the desired results. This is particularly important on larger fires, where the study data show the lowest percentage of retardant drops to have been effective.

REMOTE MEASUREMENT OF WET AND DRY BULB TEMPERATURES

Erwin H. Breuer, *Research Technician*
Intermountain Forest and Range Experiment Station[1]

Measurements of wet and dry bulb temperatures that are obtained using mercury thermometers and a sling or fan can vary among individuals because of incorrect readings of the thermometers or because of failure to achieve minimum wet bulb temperatures. A system providing an accurate readout and an easy determination of wet and dry bulb temperature is desirable. Also, the ability to read the measured values 200 yards from the weather station can offer advantages.

The sensors best suited to these requirements are thermistors. They have high sensitivity to temperature changes, and their signal is relatively unaffected by the length of the signal line.

Thermistors are "thermal resistors," i.e., resistors with a high negative temperature coefficient of resistance. As the temperature increases, the resistance decreases; and as the temperature decreases, the resistance increases. Thermistors were chosen because their large resistance change (78 ohms per degree Centigrade) provides good accuracy and resolution compared to that of a platinum resistant bulb with the same basic resistance (only 7.2 ohms per degree Centigrade).

A useful circuit for measuring temperature with thermistors can be made by using a Wheatstone bridge. As the temperature changes, the resistance of the thermistor changes, and the flow of current through the meter can be calibrated in terms of temperature. The thermistor may be mounted a great distance from the meter, and ordinary copper wire may be used to complete the circuit. This capability met part of the test requirements of the weather station, which was the effect of long transmission lines on the signal level from various fire-weather instruments.

The Wheatstone bridge circuit (fig. 1) is described as follows: Switch 1 (SW 1) is the master power switch; it sends 6 volts across the bridge to the thermistors. The two 1.78K resistors are fixed to provide balance for the bridge. Meter sensitivity was selected to match the current change as the bridge unbalances. Switch 2 (SW 2) is a double-pole, double-throw switch with a 537-ohm resistor for a null balance and a 333-ohm resistor for span adjustment. The 2K dial variable resistor is within the range of resistance as the thermistor; i.e., 1,000 ohms. The 1K fixed resistor is in parallel to the thermistor; it is used to linearize the thermistor because the thermistor resistance change is not linear to temperature change. The two thermistors used in our design have a resistance of 1,000 ohms at 25° C. and a maximum operating temperature of 150° C.

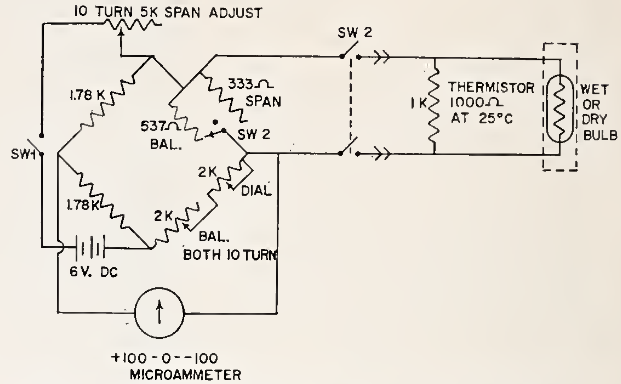

Figure 1.—Wheatstone bridge circuit. One is required for each of the thermistors.

One requirement is that the two 6-volt batteries in series be close to the fan motor to produce the speed and airflow required for the wet and dry bulb. These batteries are actuated by a relay (fig. 2) as is the battery for the solenoid valve. The switches to activate the relays are located on the console.

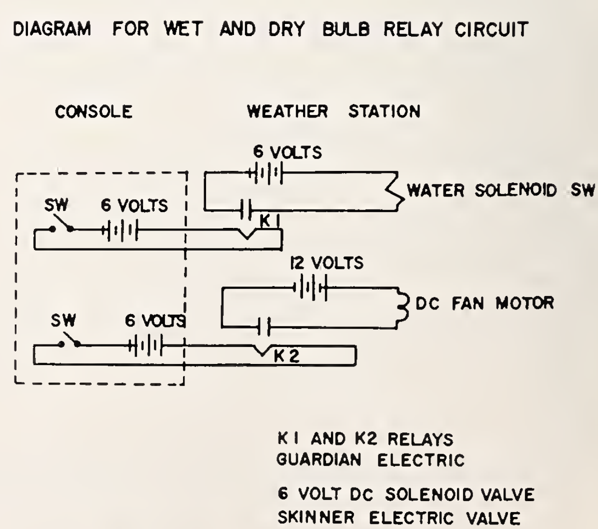

Figure 2.—Circuitry for fan and water relays.

[1] Headquarters for the Station is Ogden, Utah. The author is stationed at the Northern Forest Fire Laboratory, Missoula, Mont.

The two thermistors are mounted in place outside an air supply box (fig. 3). The water supply line of 1/8-inch tubing is placed directly over the wet bulb thermistor. Inside the air supply box are the fan, a 1-pint polyethylene bottle for water storage, and a 6-volt d.c. solenoid valve with the 1/8-inch water supply tubing narrowed at the outlet to give 3 drops per 10 seconds on the wet bulb. This amount of water will allow full wet bulb depression and maintain it long enough to allow the digital dial potentiometer to be set to the null point.

At most field stations, a remote readout will permit the weather station to be located at the most appropriate spot, even though this might be some distance from the observer. This permits the observer to take frequent readings without leaving his duty post—especially important during periods of high fire danger and heavy fire business.

The operating console is shown in figure 4. Procedures for reading the wet and dry bulb temperatures are:

1. Master panel switch to the *ON* position. (This is not shown in the illustration.)
2. Turn both wet and dry numbered dials to 70.0.
3. Turn both power switches *ON*.
4. On dry bulb, throw calibrate switch to *ON*.
5. Throw balance switch to balance, and null the meter, that is, to center zero.
6. Throw balance switch to span and adjust meter to 83 by turning span knob.
7. Recheck the null point on zero and also span at 83 on the meter.
8. Throw calibrate switch to *OFF*.
9. Null the meter on zero by turning digital dial. Result: the dry-bulb temperature reading is directly on dial.

Use same procedure for the wet bulb temperature, but with the following additions:

10. After calibration is complete, actuate the toggle switch labeled "water" to *ON* for at least 10 seconds; then turn to the *OFF* position.
11. Actuate the fan switch, and null the meter to zero by rotating the digital dial, keeping the meter on zero until the meter will no longer drop below zero. Result: the wet bulb temperature reading. Keep checking the dry bulb zero and hold on zero while fan is running.
12. Throw all switches to the *OFF* position when readings are completed.
13. Refer to wet and dry bulb conversion chart for relative humidity and dewpoint in degrees Fahrenheit.

Conclusions

The thermistor system described herein was checked during a complete fire season and was as accurate as a standard psychrometer. Rapid response, ease of reading, and location of readout near a person's work area make this unit an aid to increased work efficiency. It also provides more complete, accurate records of two important fire-weather measurements. Other measurements that are needed to calculate fire-danger ratings, such as windspeed, could easily be incorporated to make a complete remote readout system.

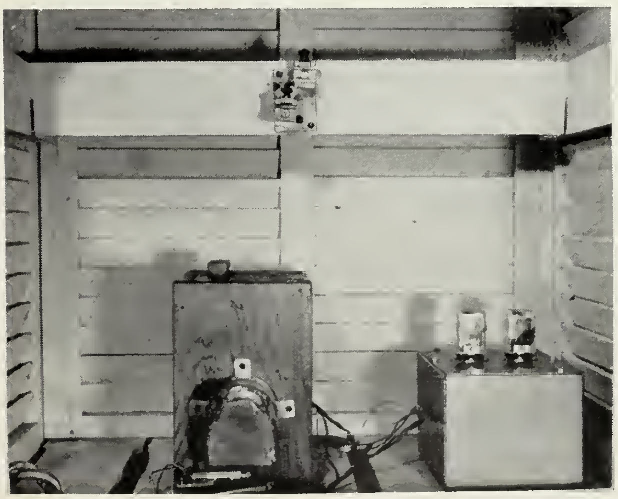

Figure 3.—Equipment is placed in the weather station shelter. The thermistors are mounted below the hood on the front of the air supply box.

Figure 4.—View of the operating console. Temperatures are read on the two digital dials.

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MAN-CAUSED FIRE SMOKEY SIGN

RUDY ANDERSON, *Fire Prevention Technician*
Black Hills National Forest

In the ceaseless battle to decrease the number of man-caused forest and range fires, personnel of the Black Hills National Forest combined some existing ideas to provide a new twist in prevention signs.

When a roadside fire occurs, a 6-foot plywood cutout of Smokey Bear is placed near the fire's origin, with Smokey pointing toward the burned area. At Smokey's feet, a plywood cutout of flames with a routed message saying "Man Caused" is mounted (fig. 1). Although the sign is simple, it is quite effective. It also receives many favorable comments from passing motorists.

Smokey and the flame was constructed from one 4- by 8-inch sheet of one-half-inch plywood. Smokey was painted on both sides in full color, and the flames were painted a fluorescent red with white letters. The letters were sprinkled with reflective beads for night viewing. A special support using 1 1/2- by 1 1/2- by 1/8-inch angle iron was constructed to speed mounting and disassembly of the sign.

The main value of the sign is its versatility. It can be put up and taken down in a few minutes. The message can be easily changed to meet changing needs. Or Smokey can be utilized in combination with permanent Forest signs.

Training Pays Off—
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ten on the side. A check of local police files revealed that our "helpful" firefighter had a record of setting fires.

The suspect was subsequently located and interviewed. When presented with the evidence—small fires, no one else in the area, his name and description of his car, his past fire record—he confessed. He described how he set one fire in the recreation area, went to a phone and reported it, returned to the area, and set two more fires while waiting for the fire crews to arrive.

At 2 o'clock in the afternoon the day after the fire, a complaint was filed with the Grant Parish District Attorney. The subject of the complaint was arrested that night and tried 9 days later.

The Kisatchie Investigator's continual emphasis on "vigilance" at all trespass scenes motivated a technician to "see" what *was* and just as important in this case—what *was not* at the scene of this particular fire.

Because of this teamwork, the Forest Investigator was given good leads to follow, with the result that a woods arsonist was brought to justice.

Good training does pay off.